POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

Contents

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Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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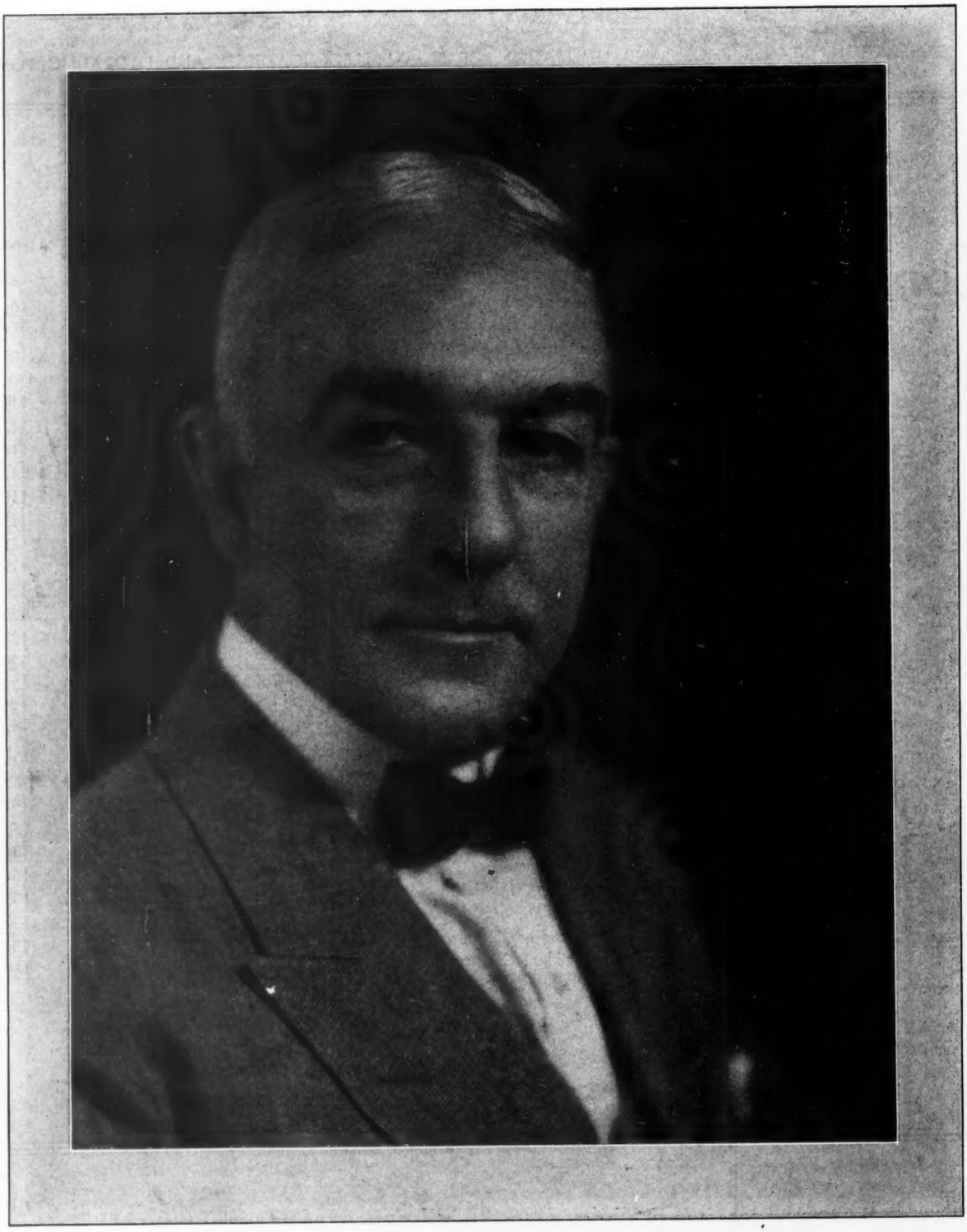

Edward R. Shaw

EDWARD R. SHAW, president of Technical Publishing Co., passed away at Barfield Sanatorium, Tucson, Ariz., Wednesday, January 12, after an illness of over six months. Mr. Shaw was born in 1870 in Corfu, N. Y., where services were held and interment took place on January 18. After school and some years in merchandising, he entered the business publication field and, following several years' experience, joined The Taylor Publishing Co. on The Engineer in 1903. In 1908 when Technical Publishing Co. was formed, Mr. Shaw became president and business manager of Power Plant Engineering. In 1910 he came to Chicago where he has been active in the affairs of business paper organizations during the succeeding years. He leaves a widow, Maude B. Shaw, and two sisters, Mrs. Charles Sumner of Corfu, N. Y., and Mrs. Calvin Wright of Alden, N. Y.

Mr. Shaw was one of the prime movers in the formation of The Associated Business Papers, Inc., and of the Audit Bureau of Circulations, serving on the Boards of Directors, also as president of A.B.P. for a term and as treasurer of A.B.C. almost since its formation.

He was a lover of horses and an ardent equestrian, winning several prizes at horse shows at the South Shore Country Club and at the International Stock Show. Fishing was another hobby, Mr. Shaw having been for many years a member of the Isaac Walton League. Delighting in social contacts, he was often seen in the Union League Club, of which he was a member, and rarely missed a meeting or convention of the National Industrial Advertisers' Association, the Chicago Dotted Line Club, Chicago Business Papers Association, Engineering Advertisers' Association, and other organizations in which he was interested.

Thus briefly chronicled are some of the outstanding accomplishments and events in a long and continuously active career, devoted unreservedly to the success of his business undertakings and allied activities which to him provided a means of serving those with whom he came in contact directly or through business activity. Careful in his own work, he required exactness of others in the conduct of business, phraseology of letters, appearance of publication issues, propriety in conducting meetings, entertainment of friends, meeting appointments and every manner of obligation.

All in the organization were impressed with his desire to serve men in the entire power plant field through the dissemination of reliable and needful information and facts concerning equipment for use in the field. He insisted that both editorial and advertising statements must never be misleading or unfair, believing that unfair statements will work to the disadvantage of any business. Intolerant of wilful deception, he respected one who had the moral courage to admit a mistake and take the responsibility.

Possessed of splendid physique and mental stamina, he was vigorous and dynamic in all his activities. To prepare for his long hours in the office,—he was first to come and last to leave, day after day for years,—a brisk ride on a spirited horse served as a tonic to prepare for the busy day ahead.

Keenly observant and painstakingly thorough in his analysis of any situation, he seldom misjudged men's motives and was quick to detect the flaw in an argument. This was recognized by associates in his own and other publishing organizations and his opinions were correspondingly respected. His memory for names, faces and events was remarkable and was a faculty that he found most helpful. Occurrences of several years past, even to small details would be described by him and practically always with absolute correctness. Rarely did he make notes during meetings or conversations yet afterwards he could quote what was said almost verbatim.

With a high and unfaltering sense of duty, which overshadowed all considerations of personal pleasure or profit, his aim was to build for the industrial publishing field an inheritance of high principles and standards of practice. The testimonials to the worth of his work, embodied in a meeting of the Associated Business Papers, Inc., in his honor and a specially designed scroll presented by the organization, were prized by him beyond words, although, unfortunately, his ill health prevented his attendance in person.

Those of us who have worked with and for Mr. Shaw through many years, who have seen his reactions to almost every phase of conditions in the publishing field, who have been recipients of his expressions of friendship in times of our personal need, honor him for the spirit which motivated his kindnesses and respect his memory for the steadfast determination with which he ordered his life's work.

A good companion, a firm friend, a staunch advocate of those things which he believed right, he will be sorely missed by a great circle of friends throughout the country.

New Upper Salmon Falls

The 18,000-kw. hydroelectric development of the Idaho Power Co. just completed is this company's sixth development on the Snake River in Idaho

THE IDAHO POWER CO. has recently completed an 18,000-kw. hydroelectric development at the Upper Salmon Falls on Snake River about 3 mi. south of the town of Hagerman, Idaho. The site is known as Upper Salmon Falls and so distinguished from the Lower Salmon Falls located 7 mi. downstream. The Upper Salmon Falls marks the upper end of the great bend in the river known as "Hagerman Bend." This is the sixth development of Idaho Power Company plants on Snake River in Idaho.

To the south and west lies a large tract of land which for many years has received a great deal of consideration because of the possibilities for its irrigation. This land is known as the "Bruneau Tract." Streaking across these vast sagebrush covered plains is the deep scar of the Old Oregon Trail. Back in the '60's Upper Salmon was a stopping place for the Wells-Fargo Express. Lands in this vicinity are marked with old "placer diggin's" and many years may still elapse before nature can obliterate the trails and scars left in the mad rush for gold.

In 1907 the Great Shoshone and Twin Falls Water Power Co., operating its Shoshone Falls plant located on Snake River 35 mi. farther upstream, in its efforts to provide sufficient power to meet the demands for the rapidly growing irrigation projects, found it necessary to increase its output. This Company, one of the five main predecessors of Idaho Power Co., as early as 1907 recognized the potentiality of the Lower and Upper Salmon falls sites for the production of electrical energy, and the proximity to its Shoshone Falls plant was a deciding factor in the selection of these sites for development, as it permitted of a convenient tie-in with their then existing system. That Company engaged the services of Mr. A. J. Wiley, one of the West's most prominent engineers, who originated and perfected the plans for an extensive program for the expansion of electrical development beginning in 1909. His studies resulted in the installation and completion of two units, each having a capacity of 2000 kw. at Lower Salmon and included the building of a considerable portion of the then proposed water carrier system for the Upper Salmon plant.

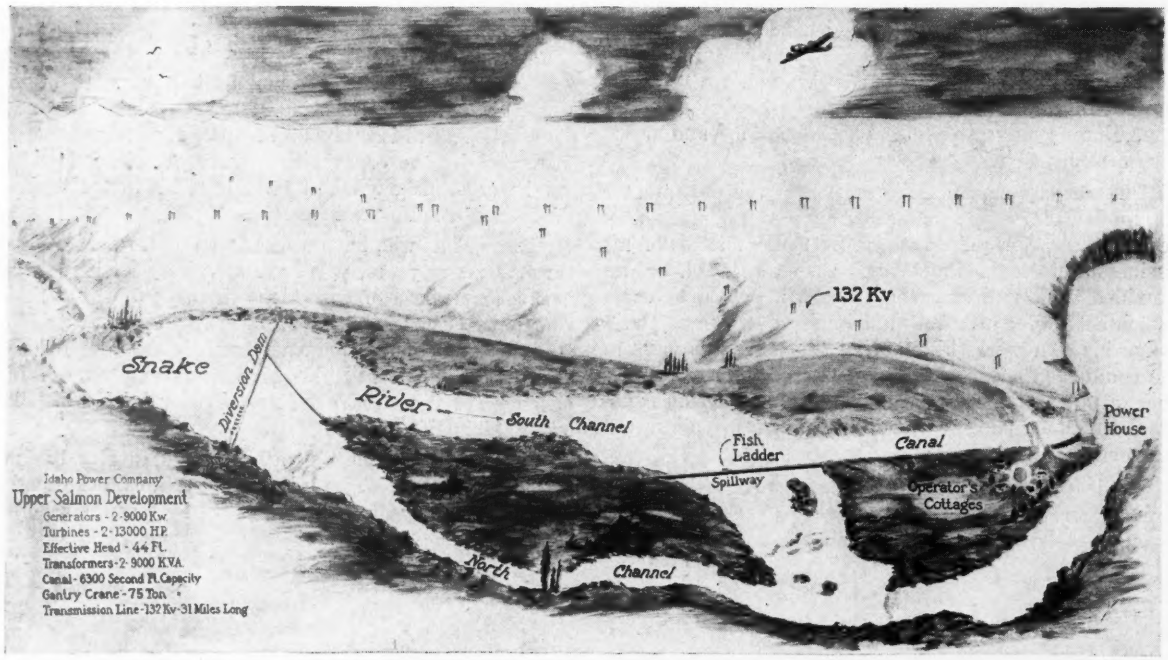

Fig. 1. Sketch plan of the Upper Salmon Falls Development

Hydroelectric Development

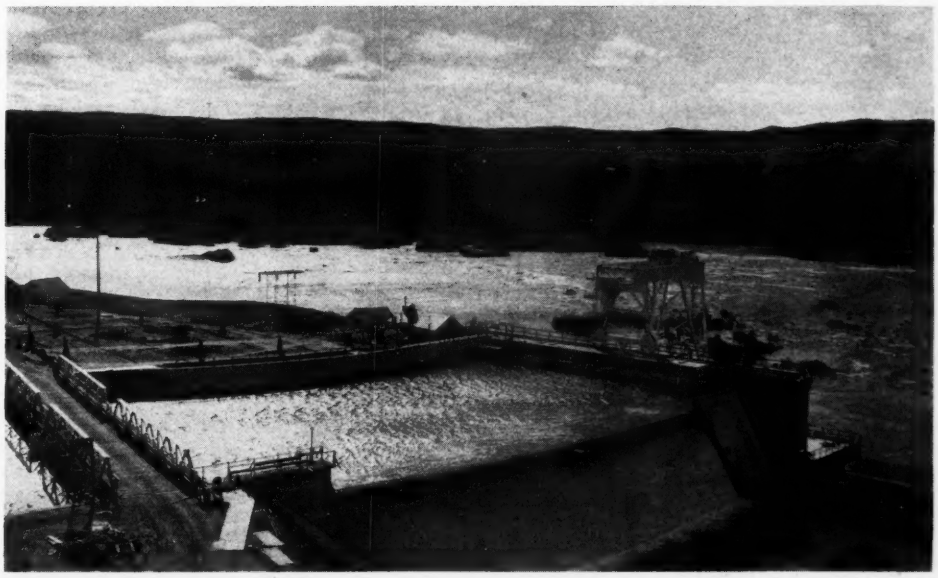

Fig. 2. Power House, Forebay, Spillway and Bridge

River Regulation

The Snake River above Shoshone Falls is a highly regulated stream, its waters being used primarily for irrigation which has reached a high stage of development in the Snake River Valley. The combined developed storage space of reservoirs in the drainage area above Shoshone Falls is approximately three million acre feet. At Milner Dam, located about 60 mi. above Upper Salmon, the final diversion of substantially all water in Snake River is made into the Twin Falls, the North Side and Gooding irrigation canals, having a combined capacity of about 8000 sec. ft. The regulation of Snake River flow above Milner Dam for irrigation has been such as to substantially eliminate flood run-off below this point for the past seven years, and as a result the river immediately below Milner Dam for the greater part of the time is virtually dry, the measured loss by seepage being as low as ten second feet. Practically speaking, Snake River starts anew at Milner Dam. Within the 25 mi. of river canyon between Milner Dam and Shoshone Falls, the accumulated monthly average flow rarely exceeds 600 sec. ft. This condition applies throughout the year, excepting for occasional periods of flood water surpluses and limited amounts of storage water released to the river below Milner Dam.

General Plan

The plan of development as shown in Fig. 1 comprises a regulating dam located at the head of the Upper Salmon Falls. Immediately below the falls is Dolman Island about a mile long which divides the river into two channels, north and south. Water is diverted into the south channel by the regulating dam and flows through it to the lower end of Dolman Island where a concrete wall connecting Dolman Island with the south bank of the river turns the water into the canal. The canal connects directly to the powerhouse.

The entire development comprises nine units or subdivisions: The construction of the Regulating Dam, Upper Canal Wall and Spillway, Canal, Lower Canal Walls and Spillway, Powerhouse and Tailrace, Substation, Regaining Wall and Yard Fill for substation, Roads, and Operators Village.

The first work, that of excavating for the powerhouse and tailrace, was started the latter part of February, 1937. Number Two unit was placed in commercial operation on September 11, 1937, and Number One unit on September 27, 1937.

The Morrison-Knudsen Co. and H. E. Cornell of Boise, Idaho, and D. J. Cavanagh of Twin Falls were the principal contractors. E. A. Woodward was field superintendent of construction and the work was done under the general supervision of H. L. Senger, Chief Engineer.

Regulating Dam

The regulating dam is a concrete structure 1617.6 ft. long. On the north side of the river there is a gravity section 191 ft. long. Adjoining this section on the south there is a tainter gate section 236 ft. long in which there are six 15-ft. by 30-ft. tainter gates, supported by concrete piers on 38-ft. centers. The piers serve the further purpose of carrying a gate hoist bridge.

The central section of the dam is a flashboard section 501 ft. long. This dam has a crest width of 2½ ft. and varies in height from 5 to 14 ft. The front face is vertical and the back has a batter of 7⅜ to 12. Two-foot flashboards are installed on this section supported by 2½ in. galvanized pipes set in sockets spaced 6 feet on centers.

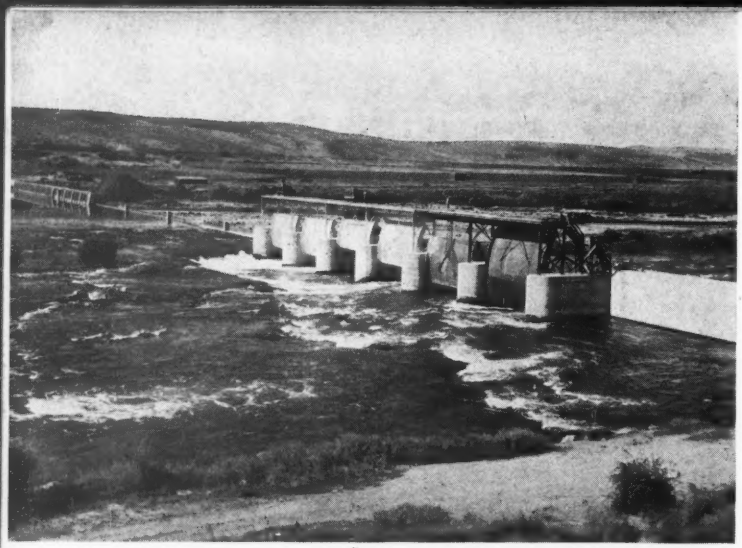

Fig. 3. Diversion Dam, tainter gates in the foreground

On the south side of the river there is a gravity section 225.6 ft. long. Adjoining and to the north of this section is the intake which is 464 ft. long and is composed of 3 sections. The south section has nine 39-ft. bays. Adjoining this on the north there are two trash gate bays of 34 ft. each. The third intake section consists of three 39-ft. bays. A low concrete dam with flashboards extending from the north end of the intake to the head of Dolman Island separates the north and south channels. The function of the dam is to confine flood water to the north channel.

Canal

At the western end of Dolman Island the south channel swings northerly to join the north channel, the river then makes a wide sweep westward to the powerhouse site and again swings sharply to the northward. The land on the south side of the river between the point where the south channel turns north around Dolman Island and the powerhouse site was high, making possible a canal location entirely in earth. After very extensive prospecting with test holes it was found that the elevation of the underlying sheet of lava was such that very little solid rock excavation would be necessary in the construction of the canal. The test holes also revealed the fact that the lava was overlaid with a strata of impervious clay. Thus natural conditions provided an ideal canal location.

The canal, including the upper canal wall and spillway, is 3495 ft. long, the length of the earth section being 2050 ft. and the wall section 1445 ft. The canal is designed to carry in excess of 6500 sec. ft. of water. At the standard section it has a base of 200 ft. and a water depth of ten feet. The sides have a slope of 2 to 1 and are protected against wave action by an 18-in. layer of loose rock. There is a 10-ft. berm along each side surfaced with gravel. The berm is 7 ft. above water level. Approximately 400,000 cu. yd. of material was moved in the excavation of the canal.

Upper Canal Wall and Spillway

The upper canal wall and spillway connects the lower or west end of Dolman Island to the south bank of the south channel and forms the north canal wall across the south channel. It is a concrete structure 1495 ft. long. The east abutment is a gravity section 45 ft. long and 2½ ft. wide on top with the upstream face vertical and the downstream face built on a batter of 8¾ to 12. The spillway is a gravity section 1400 ft. long and 2½ ft. wide on top varying in height from 4 to 11 ft. The upstream face is vertical and the downstream face built on a batter of 8¾ to 12. The crest of the spillway which is 2 ft. below the abutments has 3½-in. pipe sockets spaced 6 ft. on centers for supports for two-foot flashboards. There are four 6-ft. stop log openings extending down to the elevation of the river bed. A fish ladder having four bays provides a means for fish to pass up the river.

The upper canal wall connects to the earth canal bank by means of a concrete abutment 50 ft. long. A cutoff wall extends downstream 20 ft. from the junction of the spillway and west abutment. Adjoining the west concrete abutment the canal bank is protected by a facing of rubble masonry for 50 ft., and beyond the rubble masonry by heavy hand-laid rock riprap for 58 ft.

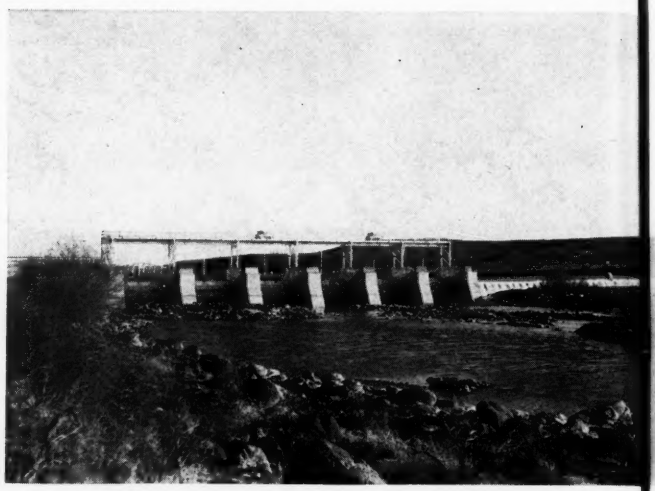

Fig. 4. Diversion Dam, tainter gates looking upstream

The canal connects to the east wall of the powerhouse by means of concrete walls. The south wall is a gravity section 141.6 ft. long with an average height of 37 ft. Where this wall connects with the earth bank a cutoff wall extends into into the hillside approximately 90 ft. The cutoff wall rests on solid rock and extends well into the impervious clay strata overlaying the rock. The canal bank east of the concrete wall is lined with a covering of rubble masonry 70 ft. long, beyond the rubble masonry rock riprap extends 75 ft.

The north wall is also a gravity section 262 ft. long with an average height of 37 ft. A spillway 150 ft. long is provided in this wall. The crest of the spillway is 7.3 ft. below the top of the wall. The canal bank east of the concrete wall is lined with a covering of rubble masonry 70 ft. long. Beyond the rubble masonry, rock riprap extends 75 ft.

Powerhouse

The substructure of the powerhouse, designed to meet the requirements of the scroll cases and draft tubes of the hydraulic units and to support the superimposed loads of generators, water wheels and water thrust, is constructed of reinforced concrete. The maximum depth of the draft tubes is 32 ft. below tailwater.

The draft tube is divided into two parts by a central bearing wall. Each opening into the tailrace is 14 ft. 4 in. high by 19 ft. 6 in. wide. Structural steel guides on the downstream face of the substructures are provided for draft tube gates. The low setting of the water wheels relative to the tail water level made it necessary to provide for gates at the outlet of the draft tubes to prevent the unit from being flooded by tailwater when unwatered for inspection or repairs. The two draft tubes are separated by a 12-ft. bearing wall. In this wall is located a pump sump seven feet in diameter extending five feet below the draft tube. The draft tubes can be drained into the pump sump through 16-inch pipe laid under the concrete floor of the draft tubes. The pipes are closed off in the pump sump by means of 16-inch angle gate valves. Weep holes in the draft tube floors relieve excessive uplift pressures.

The generators being outdoor type are not housed in a building. They are located on a concrete deck 25 ft. above tailwater, and at the station yard level. A pit 17 ft. in diameter extends from under the generators to the top plate of the turbines.

The east wall of the powerhouse is of reinforced concrete raising 30 ft. above the generator deck. The lower canal walls connect to either end of this wall to form the canal forebay at the powerhouse. The intake openings to the scroll cases through the east wall are 18 ft. high by 19¼ ft. wide. One structural steel intake gate is provided. This gate weighs 25 tons. When not in use it is stored in a pit located in the top of the east wall.

The trash racks in front of the scroll case openings

Fig. 5. Operators' Village. Four cottages and water tank

are 110 ft. wide by 44 ft. deep. These racks are made up in panels 9 ft. wide and 14 ft. long, which slide in structural steel guides. There are 12 sections of 3 panels each. The panels are made of 2-in. extra heavy galvanized pipe spaced 11 1/6 in. on centers welded to a structural steel frame. Trash is handled by means of a mechanical rake. Trash is hauled up the racks and deposited in a trench in the intake operating floor. Water for carrying away the trash is admitted to the south end of the trash trench through a tunnel and sluice gate in the south canal wall. The trash is deposited in a collecting basin on the north side of the station where it is burned after drying.

The operating room is on the downstream side and below the generator deck. It is 12½ ft. wide and 60 ft. long. Here are located the switchboard, low tension oil switch cubicles, governors, and oil pressure receivers, control battery, and local service switchboard. At either end of the operating room a tunnel connects with the generator pits. The generator pits give access to the top of the turbines, governor servo motors, turbine gate operating equipment, and turbine guide bearing.

Below the operating room is the pump room 12½ ft. wide and 60 ft. long. In this room are located the governor oil pumps, governor oil sump tank, air compressors and receivers, service water pumps, sump pumps, air washer and chlorinator for the water system.

Access to the scroll cases, draft tubes and pump sumps is provided through an inspection room 15 ft. wide and 21 ft. 4 in. long located below the pump room. Tunnels from this room lead to man-way doors in each scroll case. Manholes in the floor connect with the draft tubes.

The operating and pump rooms are each heated with two 15-kw. electric heaters. The heaters are controlled by thermostats. A 2000 cu. ft. air washer is installed for station ventilation.

There are two main generating units, each consisting of a vertical shaft turbine direct connected to a vertical waterwheel outdoor generator.

The turbines are S. Morgan Smith vertical shaft, single runner, wicket gate turbines, rated capacity 13,000 hp. at 44 ft. net effective head and 138.5 r.p.m. The runners are the Smith-Kaplan type having four blades. The maximum diameter of the runner is 12 ft. 6¼ in.. and its weight completely assembled on the shaft is about 55,000 lb. The turbines are set in concrete scroll cases.

The governors, S. Morgan Smith, are of the oil pressure actuator type having a capacity of 80,000 ft. lb. They are designed to operate the gates over the full range in three seconds and are sensitive to a speed variation of ¼ of 1 per cent.

The generators are General Electric and Westinghouse, each 9000 kv-a., 9000 kw., 1.0 p. f., 3 phase, 60 cycle, 6900 v., 138.5 r.p.m. totally enclosed vertical waterwheel generators for outdoor service with direct connected 125 v. main and pilot exciters. Each generator is equipped with an automatic voltage regulator of the rheostatic type. The generators are Y connected

Fig. 6. Power House, gantry crane and substation

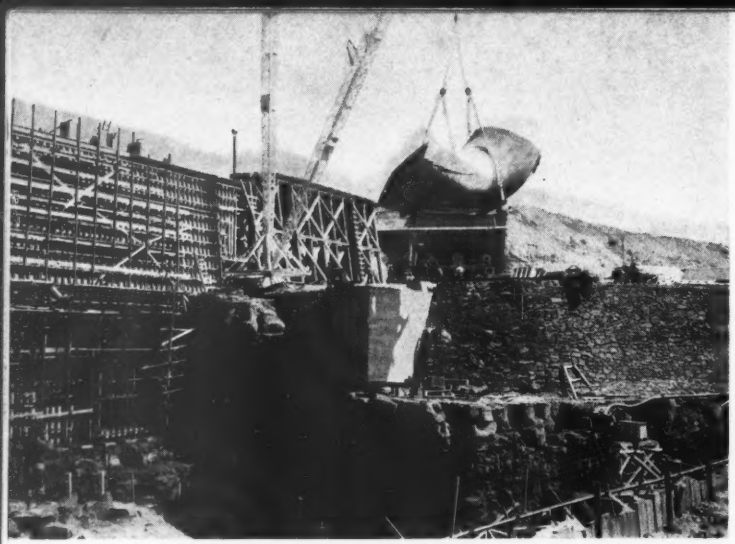

Fig. 7. Section of Draft Tube being lowered to position

with the neutral brought out and connected to ground through a disconnecting switch.

The generators are self-ventilating, the air being re-circulated through a completely closed duct system located on opposite sides of the unit. Each ventilating duct is equipped with a 75 deg. C. surface air cooler. Cooling water for the generator coolers can be supplied from three sources; the forebay, service water pumps, or from a 30,000 gal. tank.

The thrust bearings for the two generators are Kingsbury. These bearings are water cooled. The General Electric unit has a 49-in. bearing carrying a load of 246 tons, including 158 tons of hydraulic thrust. The Westinghouse unit has a 56-inch bearing carrying a load of 230 tons, including 158 tons of hydraulic thrust.

The transformers consist of two Allis-Chalmers 9000 kv-a., 3 phase, 60 cycle outdoor type self-cooled transformers, 138,000-6600 v. They are connected Y on the high tension side and delta on the low. Each transformer is equipped with 3 bushing type current transformer, 100-5 amp. installed on the high voltage bushings.

Each generator and transformer is connected to form a generator transformer unit and the two units are paralleled on the high tension side of the transformers.

The switching equipment for each unit consists of a 15,000 volt, 1200 amp., 100,000 kv-a. interrupting capacity 3-pole single throw, electrically operated oil circuit breaker and 3 indoor gang operated disconnecting switches, 1200 amp., 2500 v., single pole, single throw, for generator control, together with a 3-pole, single throw, motor operated, 132,000 v., 600 amp. air break switch for connecting the transformer to the 132 kv. bus. The switchboard consists of two duplex type steel panels with fixed front instrument sections and a hinged rear relay section. Each generator oil switch and instrument transformer is mounted in a separate cubicle.

The relay protection for each unit consists of a differential loop around the generator and low tension equipment and also a differential loop around the generator and main transformer. Overload protection is provided for with induction relays operated by current transformers in the generator neutral. The neutrals on the 132 kv. side of the transformers are grounded through a 15,000 v. 40 to 5 amp. outdoor current transformer for ground relaying on the transmission line.

Direct current for switch operation is furnished by a 60-cell storage battery having a discharge rate of 150 amp. for one minute. The battery is charged by a 750 watt, 140 v. Diverter-Pole battery charging motor generating set. The battery is also used to supply emergency lighting in the operating room.

Station service can be supplied by each generating unit through a 300 kv-a., 3 phase, 6900 v. Y to 240 v. delta connected outdoor transformer. These transformers are connected to the main transformer leads just outside the generator oil circuit breaker disconnecting switches. Power from these transformers is distributed through a 220 volt load center. The load center is equipped with hand operated circuit breakers with thermal overload protection and instantaneous trip and have an interrupting capacity of 10,000 amp. at 250 v. Auxiliary station service is supplied by a 100 kv-a., 3-phase, 2400 v. delta to 240 v. delta outdoor transformer. Service for this transformer is from a 44 kv. substation located at the diversion dam. Station lighting is furnished by a 25 kv-a., single phase, 240 v. to 120/240 v. transformer.

The substation is located in the yard to the south of the station structure. A dry riprap wall approximately 200 ft. long and 25 ft. high sustains the yard fill on the river side. The substation yard is 73 ft. by 80 ft. surrounded by an 84-in. galvanized wire fence. The transformers are located on the north side. A track leads from each transformer foundation to the gantry crane for moving the transformers under the crane. Two galvanized steel structures support the transformer 132 kv. air break switches. The 132 kv. bus is supported on Lally columns. A galvanized steel tower serves for dead-ending the transmission line and connecting it to the 132 kv. bus.

A 132 kv. transmission line approximately 30 mi. long connects the Upper Salmon development to the 132 kv. system at Shoshone Falls. The structures of this line are two-pole, H frame type constructed of 60-ft. poles with standard spacing of 600 ft. Two 2-in. by 10-in. by 29-ft. crossarms bolted on either side of the poles support the 250,000 c.m. stranded copper cable with strings of 10 Superior insulators. Two overhead ground wires of high strength steel are suspended from the top of the poles 7 ft., 6 in. above the crossarms.

Operators Village

Idaho Power Company is justly proud of the quarters provided for its operators at this new plant. The village site is located at the extreme west end of an island formed by the canal and the north channel of the river. A bridge near the powerhouse allows the only means of ingress and egress to the site. The "village" consists of four modern and attractively designed cottages arranged in a semi-circle to the north of the powerhouse. The four homes face a loop driveway surrounding a small park beautifully landscaped with shrubs, trees, and a spacious lawn. The cottages are finished in smooth white stucco trimmed with silver and are thoroughly modern inside and out. They are all alike with the exception of the chief operator's home which has an extra room extending above the flat roof of the first floor. The water moat and abundant greenery should serve to reduce the temperature during the hot summer months and thus maintain a comfortable and pleasant environment for the operators and their families.

In this installment of this series on Modern Turbines, Mr. Newman discusses the subject of performance charts. This particular phase of turbine knowledge covers so much territory, however that it has been broken up into two parts. This installment considers their forms and derivation. Further considerations of performance charts will be considered in the next article which will appear in the March issue.

MODERN TURBINES*

By
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Lynn, Massachusetts

IT IS STRANGE that something as simple in principle as a steam turbine could so often require such complexity in the appearance of its performance charts. Yet this is a direct result of the flexibility of the turbine. Were the turbine less adaptable to a wide variety of applications, it would have fewer variables. But being the most flexible of all prime-movers it is not uncommon for a turbine designer to be faced with ten or more variables affecting the capacity alone! Every one of the variables must be taken into account in preparing the performance chart. To do this, great ingenuity on the part of the designer is often required to devise means for expressing the performance in a convenient, easily used form. But great skill is not required to read and interpret the curves so prepared. All that is needed is an elementary knowledge of the various types of performance charts and their relationship to each other. With this as a background, turbine performance charts should be of greater interest and increased utility.

Of the many ways in which the steam performance of turbines may be expressed, none is more important than the relation between weight of steam flowing through the turbine and resultant power developed. A chart of these two variables can furnish much valuable information to both purchasers and operators of turbines. The purchaser of a turbine will use such a chart as one of the most important sources of data on which to base his initial selection of the proper turbine. The operator of turbines will study the steam flow versus output charts of all of his turbines to determine the most economical division of loads between several turbines operating in parallel.

Except for straight condensing or noncondensing turbines where guarantees are frequently given by a convenient tabulation of steam rates, performance is usually expressed in the form of charts or curves. Fig. 1, for example, is a typical Throttle Flow versus Output curve representative of the performance of a straight condensing or noncondensing turbine. Note that there are only two variables, "throttle flow" and "output". This elementary curve of the relation between throttle steam flow and output is the basis of practically all performance charts for every type of turbine. The relatively complex appearing chart (Fig. 8) for a double automatic extraction turbine illustrates this; being the same simple Throttle Flow versus Output curve, Fig. 1, with lines of constant extraction flow added. If it is remembered, that all Steam Flow versus Output charts are basically simple relationships similar to Fig. 1, it will be easy to become familiar with even the most complicated charts.

Let's examine Fig. 1 in some detail. Note that it is shown as a straight line originating at a flow above the zero axis. This curve is known as the "Willans Line", and is substantially straight from no-load to full load for almost all turbines regardless of type. The throttle steam flow at no-load (the no-load intercept) represents the quantity of steam required to supply the no-load losses of the set. Its magnitude varies with different types of turbines from about 10 to 30 per cent of the full-load flow, which indicates the importance of keeping turbines fairly well loaded when economy is important.

The Steam Rate versus Output curve, Fig. 2, may be derived from Fig. 1 by dividing throttle flows by corresponding outputs (and, conversely, the Throttle Flow vs. Output curve may be obtained from a tabulation of steam rates by multiplying the steam rates by the corresponding outputs). The usual characteristic steam rate curve of conventional turbines with

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multiple inlet valves is relatively flat from about one-half to full-rated load. Stated another way, turbines maintain high efficiency over a wide range of loads.

Before considering the performance charts of other types of turbines, let's examine the limits for Fig. 1. The output of the turbine, when operated with constant steam conditions, is limited by the maximum throttle flow for which it is designed. Usually turbines for industrial manufacturers come within the range of 500 to 7500 kw., and most of these drive generators. Such turbines are normally designed for best efficiency at full load but have capacity to carry 25 per cent overload at improved generator power-factor. Unlike other prime-movers having little or no overload capacity turbines may usually be designed for appreciable overloads without adversely affecting the efficiency at normal loads.

This inherent characteristic permitting the turbine to be designed for overload accounts for the usual design normally rated at the maximum capacity of the generator at .80 power factor, but able to carry the 25 per cent greater output at 1.0 power factor. The generator has its own limits. It is limited to its normal rated load at rated power factor (usually .8) but can carry greater loads at higher power factor provided the rated kv-a. is not exceeded. (kw. output is equal to kv-a. output multiplied by the power factor). Both turbine and generator limits could be added to Fig. 1, resulting in a chart having an appearance similar to Fig. 3.

The transition from the Throttle Steam Flow versus Output curve of a nonextraction type turbine to the performance charts of various types of extraction turbines is a simple process. To illustrate this transition, suppose that the nonextraction turbine, Fig. 1, were designed as an automatic extraction turbine having an opening in the casing for extraction of steam at a constant controlled pressure in the extraction stage. The extraction turbine will have a Throttle Steam Flow versus Output curve like Fig. 1 when operated with no extraction. But as extraction flow is increased the throttle flow at a given load must also increase, with the result that there will be a family of parallel lines each substantially straight and equally spaced. (Fig. 4.) Instead of the chart being a single line, it is now a family of lines from which it is possible to read the throttle flow at any load and extraction flow within the limits of the turbine. But the limits are not shown on Fig. 4.

Extraction turbines are made up of high pressure and low pressure sections each of which may be considered as a separate turbine driving the same shaft but operating in "steam" series. Each turbine has its own admission control valves and each turbine is designed for some maximum flow beyond which operation at normal conditions is not possible. The limits of the high pressure section and low pressure section are shown on Fig. 5 by the limit lines.

Note the maximum throttle flow limit corresponding to the same limit on Fig. 3. This represents the maximum flow which the high pressure section can pass when the turbine is operated with its normal steam conditions. The corresponding limit for the low pressure section is the one titled "maximum flow to exhaust". The other limits so far discussed were rigid ones; here is a limit beyond which the turbine can operate. It represents the maximum exhaust section flow at the design extraction pressure. With a higher steam pressure at this point more flow than the limit indicates could be passed through the exhaust section. So the turbine can operate in the region to the right of the maximum flow to exhaust limit, but in this region cannot maintain normal extraction pressure.

What happens can be ilustrated by an example in which the design extraction pressure is 100 lb. per sq. in. Abs. Suppose that there is no demand for extracted steam and that the load on the turbine has increased to the point where the exhaust section flow is up to its limit. At the maximum exhaust section flow the extraction control valve is in its wide open position, no longer controlling flow to the exhaust section. Can the turbine carry a greater load? It certainly can, but the extraction pressure must rise. The nozzles admitting steam to the low pressure section are now openings with fixed areas and the pressure at the extraction opening will vary with the flow to exhaust. With an increase in load a greater flow will come through the high pres-

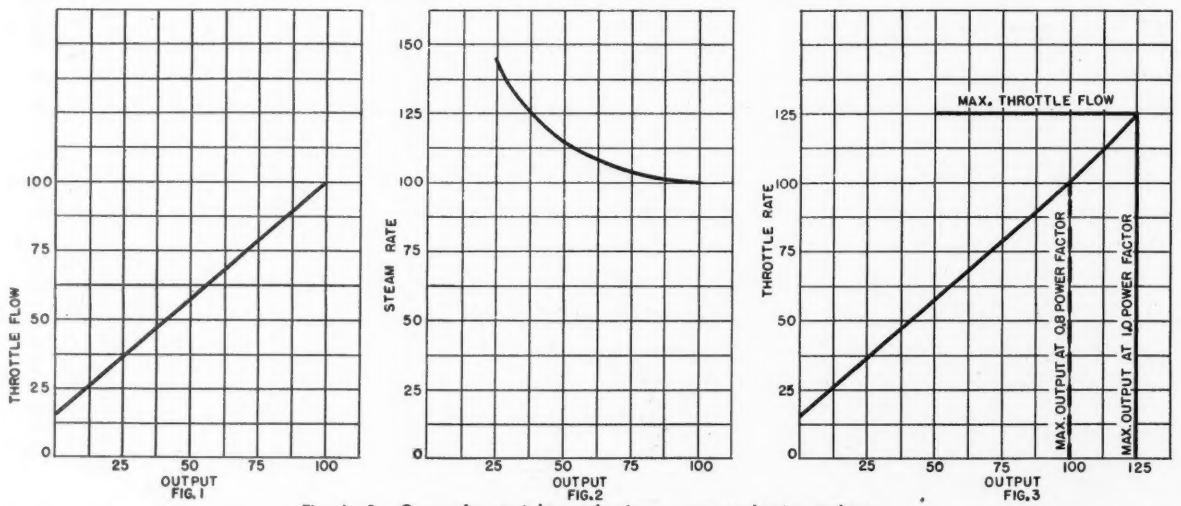


Fig. 1—3. Curves for straight condensing or non-condensing turbines

On these, and succeeding charts, the scales are in per cent. "Throttle flows" are in per cent of the flow required to deliver full rated output with no extraction. "Steam rates" are in per cent of the steam rate at full rated output. "Outputs" are in per cent of the output at full rated output.

sure section than the exhaust section can pass at the normal extraction stage pressure of 100 lb. per sq. in. Abs. So the pressure in the extraction stage rises until the flow can go through the exhaust section. How much the pressure will rise can be estimated by the rule:

> "The absolute pressure at an uncontrolled extraction opening is approximately proportional to the flow through the stage following."

Thus if the flow through the exhaust section (the extraction control valve is wide open and no longer in control) increases 10 per cent the extraction stage pressure must increase 10 per cent. And the 100 lb. per sq. in. Abs. normal extraction pressure would increase to 110 lb. per sq. in. Abs. Because of the fact that the maximum exhaust section flow is a different limiting value at different pressures, it is usually called the limit of "minimum extraction at which the normal extraction pressure can be maintained." Remember, though, that the extraction pressure rises only in the region beyond the limit line; at all points within the limits of the chart the extraction governor is in control and maintains the extraction pressure substantially constant.

There is another limit on Fig. 5 still to be mentioned. This is the limit on the left hand side of the chart labelled "minimum flow to exhaust." When the turbine is operated at any point on this line substantially all of the output is coming from the high pressure section. The extracted steam alone is sufficient to carry the load with the flow to exhaust section reduced to a minimum. So the limit of "minimum exhaust flow" may also be called the limit of "maximum extraction."

Now an interesting possibility occurs. Why not make the "minimum flow to exhaust" equal to as near zero as possible when the extraction control valve is in its closed position? Sometimes this is done, but usually the minimum amount of steam for which the exhaust section is designed will be determined by the amount of steam required to cool the exhaust stages, and not by the minimum leakage flow through the extraction control valve. Possibly it seems strange to think of high temperature steam cooling anything. But cooling is relative. If no steam were passed through these stages to carry away the heat generated by rotation losses the buckets of certain turbines might actually get hot enough to melt! Just as a meteor becomes incandescent after friction with the air, so could friction between the buckets and the steam in a turbine generate extremely high temperatures if steam were not passed through the turbine to carry away the excess heat. Modern extraction turbines are designed so that under any normal conditions of operation the flow to exhaust cannot be reduced below safe limits.

TABLE OF LIMITS

Type of Turbine	The Limit Of	Means That This is The Limit Of
Single Automatic Extraction	Max. Exhaust Flow	Minimum extraction flow (without pressure rise in the extraction line)
	Min. Exhaust Flow	Maximum extraction flow
Double Automatic Extraction	Max. Intermediate Flow	Minimum high pressure extraction flow (without pressure rise in high pressure extraction line). May limit maximum low pressure extraction flow.
	Min. Intermediate Flow	Maximum high pressure extraction flow.
	Max. Exhaust Flow	Minimum low pressure extraction flow (without pressure rise in low pressure extraction line). May limit load which can be carried with small extraction flow requirements.
	Min. Exhaust Flow	Maximum low pressure extraction flow.
Mixed Pressure	Max. Exhaust Flow	Maximum low pressure admission.
	Min. Throttle Flow	Maximum low pressure admission.
All	Max. Throttle Flow	Maximum flow of steam to inlet of the turbine. May limit load, or extraction flow, or both.

Another type of turbine having a performance chart similar in appearance to the charts of extraction turbines is the mixed-pressure turbine; a turbine designed to admit low pressure steam in addition to high pressure steam. Their performance charts, Fig. 6, look much like the performance charts of extraction turbines. Note, however, that the throttle flow is reduced as additional low pressure steam is admitted, instead of the throttle flow being increased to compensate for the steam being extracted. The chart is read in the same way as the other charts; simply read the throttle flow at the required output and low pressure admission steam flow. Limits for charts of this type have a significance similar to extraction turbines but now it is the high pressure section that must be designed so that its minimum flow doesn't go below safe limits; under certain conditions of operation the low pressure section will probably carry

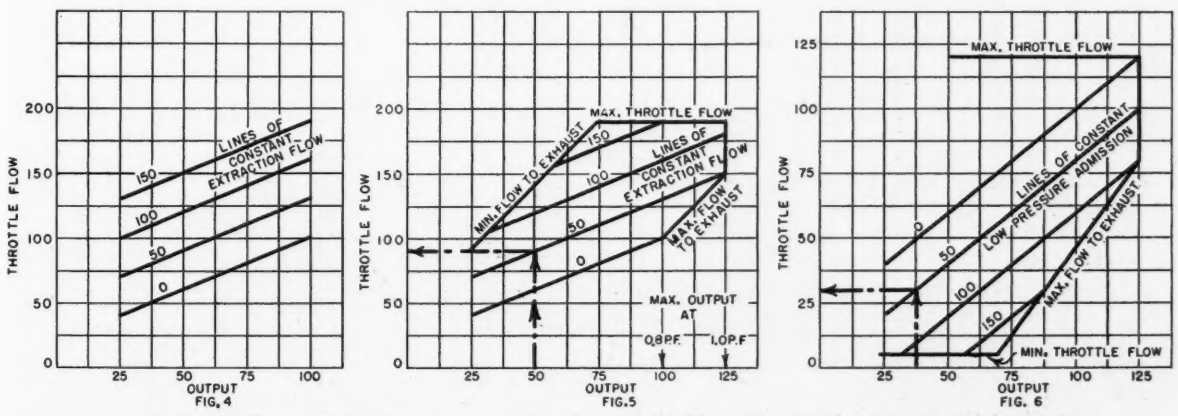
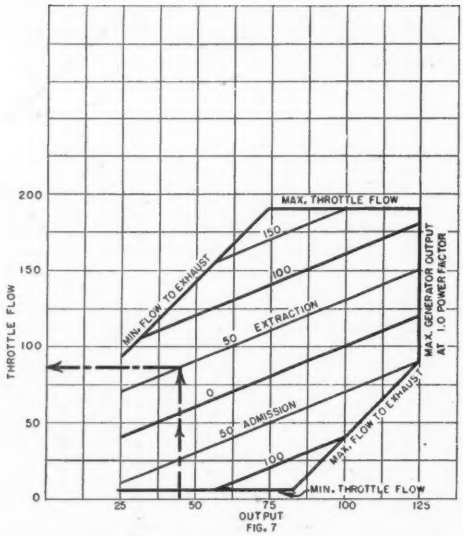


Fig. 4. Throttle flow vs. Output for single automatic extractions (Fig. 4 and 5) and mixed pressure turbine (Fig. 6)



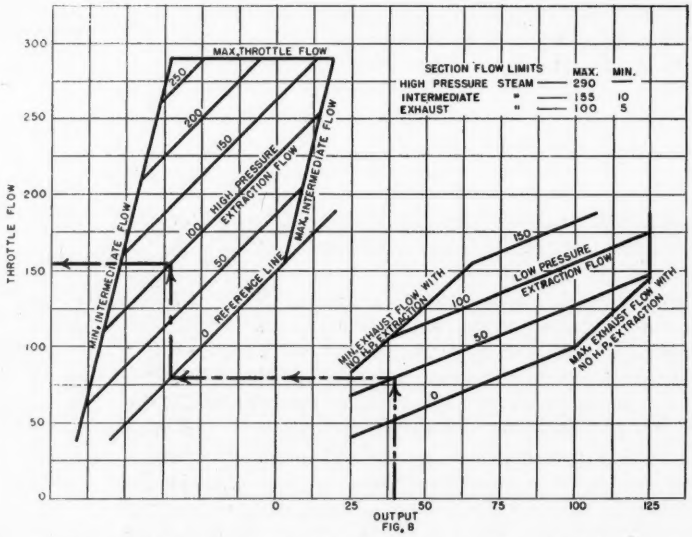


Fig. 7 and 8. Performance charts for single automatic extraction or mixed pressure (Fig. 7) and double automatic extraction (Fig. 8)

all of the load and the high pressure section will be doing no work. The limit for such operation is the "minimum flow to throttle line", sometimes called the line of "maximum low pressure admission."

The maximum flow to exhaust section, shown by the right hand limit (Fig. 6) is usually termed the limit of "maximum low pressure admission." This is the maximum flow which the exhaust section can pass at the design admission pressure. Like the extraction turbine, the exhaust section of a mixed pressure condensing turbine can pass a greater flow with a higher pressure in the admission stage. So if it were possible to increase this pressure (which usually is not feasible in the case of mixed-pressure turbines) the turbine could operate in the range to the right of this limit.

Occasionally turbines are designed to either extract or admit low pressure steam at the same opening in the

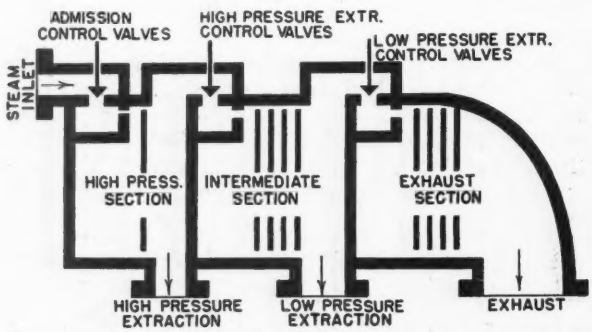


Fig. 9. Double automatic extraction turbine

turbine. Performance for this type of turbine is shown by charts similar to Fig. 7. The limits for Fig. 7 are a combination of limits for Fig. 5 and 6 with the same comments applying.

How can you tell from examining the performance chart of an extraction turbine just what are the limiting flows to exhaust? Simply remember *that the flow to exhaust is equal to the throttle flow minus the flow of steam extracted.* Then refer to the chart, and read the corresponding throttle flow and extraction flow at any point on the limit line. For example, on Fig. 5, the minimum flow to exhaust cuts off the line of constant extraction flow labeled 100 at a throttle flow of 105. So the minimum exhaust flow is 5. The maximum exhaust flow limit cuts off the line of constant extraction flow labeled 50 at a throttle flow of 150. So the maximum flow to exhaust is 50. The limiting flow for any section of any extraction turbine may be easily determined by reading the throttle flow at any point on a limit line and subtracting the steam extracted from the turbine *ahead* of the section. (In the case of mixed-pressure turbines the low pressure steam admitted must be *added* to the throttle flow to determine the total flow to the section following the mixed pressure opening.)

The transition from the simplest type of Steam Flow versus Output curve (Fig. 1) to the performance chart of a double automatic extraction turbine (Fig. 8) is again an easy process. Turbines of this type have three sections each of which may be likened to separate turbines mounted on the same shaft but operating in "steam series." These separate turbines are usually called high pressure, intermediate, and exhaust sections. At fixed pressures each section is limited to a

(Continued on p. 121)

HIGH PRESSURE SECTION

Maximum flow—This is the maximum throttle flow, determined by the maximum simultaneous extractions at the maximum required output.

Minimum flow—Does not appear as a limit unless the turbine is suitable for mixed pressure, but is fixed by the cooling steam requirements.

INTERMEDIATE SECTION

Maximum flow—Determined by the maximum low pressure extraction occurring at the maximum load with minimum high pressure extraction. It may limit the minimum high pressure extraction, or the maximum low pressure extraction.

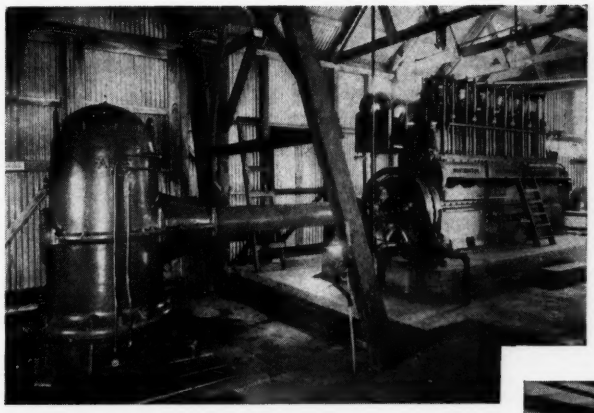
Minimum flow—Determined by the cooling steam requirements of the intermediate section. It is a limit of maximum high pressure extraction.

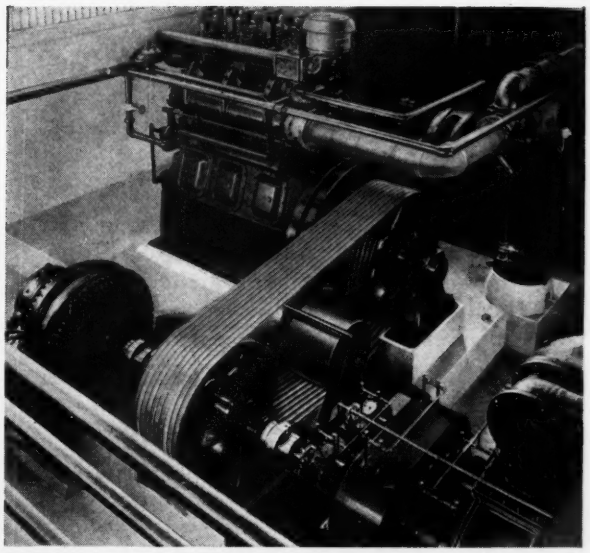
EXHAUST SECTION

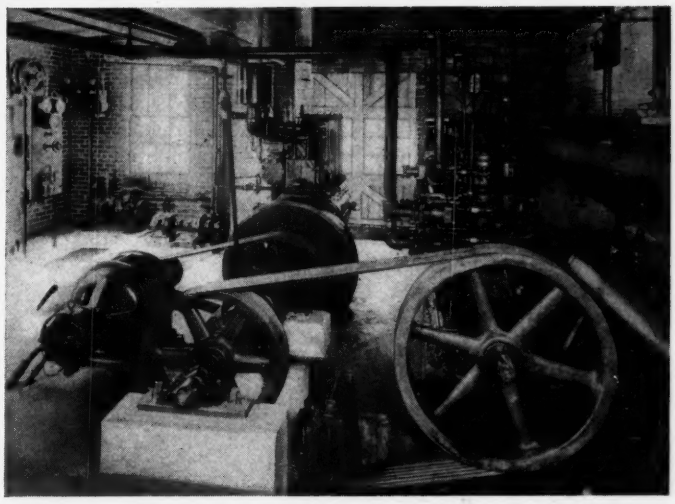
Maximum flow—Determined by the maximum load to be carried with minimum extraction from each opening. It limits the minimum low pressure extraction.

Minimum flow—Determined by the cooling steam requirements of the exhaust section. It limits the maximum low pressure extraction.

Flexibility of Engine Drive



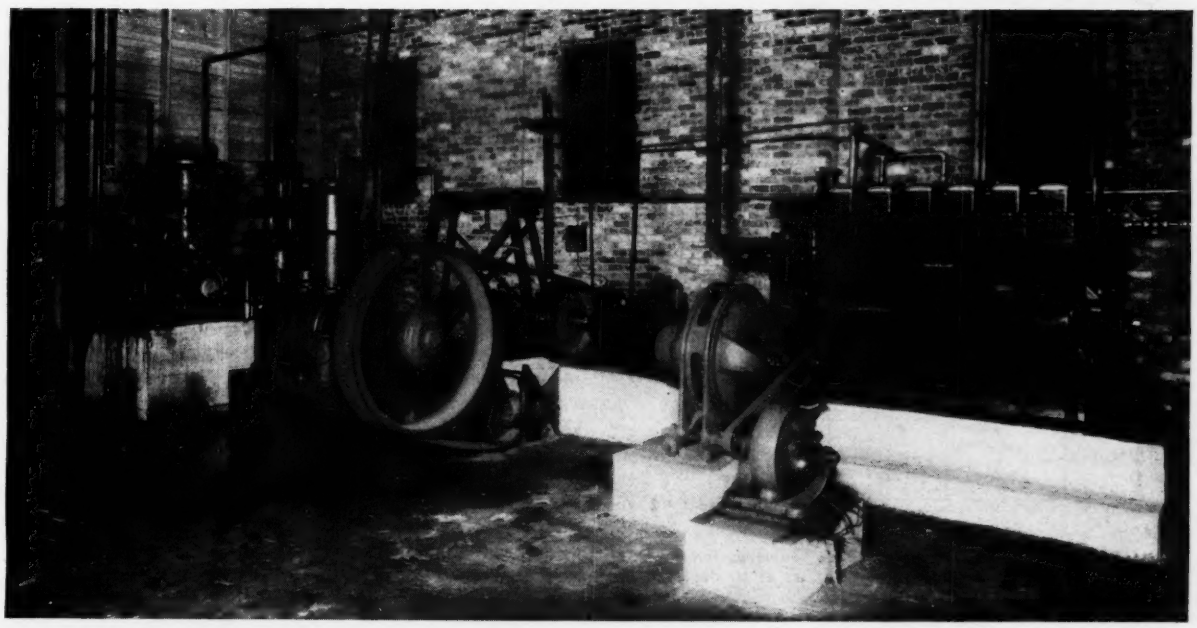




Do you have several machines that would make a good engine load? If you have don't forget that the engine, used in conjunction with modern drives, may easily be arranged to drive more than one machine. Several typical installations of this kind are shown on this page through the courtesy of the Worthington Pump & Mach. Corp. Although they all happen to be gas engines the application applies equally well to Diesels.

At the top of the page is a sewage gas engine driving both a rotary blower and an electric generator through a Multi-V-Drive. The engine above drives but a single machine, a vertical pump through one of the new Farrel Precision Right Angle Drives, a speed increasing bevel gear unit which incorporates a thrust bearing to support the pump shaft and rotor.

At the right is an engine driving a refrigeration compressor and an electric generator, very practical for ice plant modernization. The installation shown at the bottom of the page is somewhat similar, but the arrangement is slightly different and the generator has a V-belted exciter instead of a direct connected one.



Performance of Two-Cycle Supercharged Engines

Tests made by the N. A. C. A. and reported in Technical Note No. 610 show that both the horizontal and vertical air-entry angles have an important bearing on engine performance.

By Sherod L. Earl and Francis J. Dutee

AN INVESTIGATION was made to determine the effect of variations in the horizontal and vertical air-entry angles on the performance characteristics of a single-cylinder 2-stroke-cycle compression ignition test engine. Performance data were obtained over a wide range of engine speed, scavenging pressure, fuel quantity, and injection advance angle with the optimum guide vanes.

The optimum horizontal air-entry angle was found to be 60 deg. from the radial and the optimum vertical angle to be zero, under which conditions a maximum power output of 77 gross brake horsepower for a specific fuel consumption of 0.52 lb. per brake horsepower-hour was obtained at 1800 r.p.m. and 16.5 in. of Hg. scavenging pressure. The corresponding specific output was 0.65 gross brake horsepower per cubic inch of piston displacement. Tests revealed that the optimum scavenging pressure increased linearly with engine speed. The brake mean effective pressure increased uniformly with air quantity per cycle for any given vane angle and was independent of engine speed and scavenging pressure.

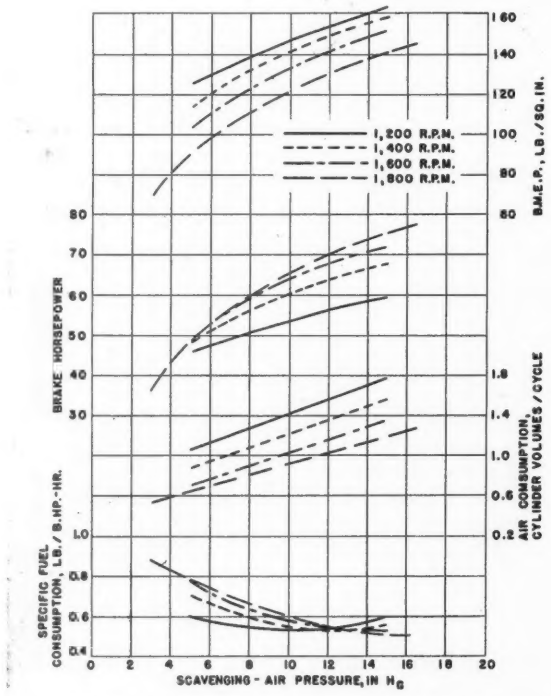


Fig. 1. Effect of scavenging air pressure on engine performance. In these tests the horizontal air-entry angle was set at 60 deg. and the vertical at zero degree which from previous tests had been found to give optimum performance

Effect of scavenging-air pressure on engine performance at 98 per cent maximum power settings with the optimum air-entry vanes is shown in the curves of Fig. 1. The power output increased with scavenging-air pressure and engine speed as was to be expected. Also, the air consumption increased linearly with scavenging-air pressure and varied approximately inversely with the engine speed. The specific fuel consumption for the different engine speeds decreased steadily and passed through a minimum when the scavenging-air pressure was increased. The scavenging-air pressure at which the minimum fuel consumption occurred increased linearly with engine speed.

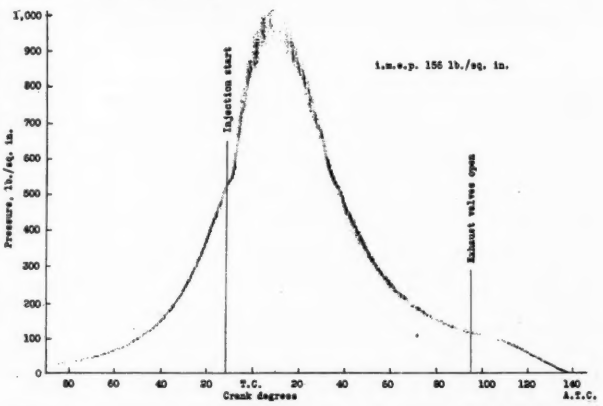


Fig. 2. Pressure-time indicator card for: a horizontal air-entry angle of 60 deg.; a vertical air-entry angle of zero deg.; an engine speed of 1800 r.p.m.; a scavenge air presure of 15 in. of mercury; and a maximum rate of pressure rise of 50.5 lb. per sq. in. per deg.

A possible explanation for this condition lies in the probability of an optimum air velocity for scavenging and for fuel and air mixing at each engine speed and, as the speed is increased, the scavenging-air pressure must be increased accordingly. These data indicate, therefore, that there is an optimum scavenging-air pressure for each engine speed, above and below which it is less economical to operate.

Cross-plotting the performance data corresponding to the optimum scavenging-air pressure for each engine speed shows clearly the improvement in power output to be obtained by increasing the engine speed and the scavenging-air pressure together. Examination of the test data shows a definite relationship between brake mean effective pressure and air consumed in cylinder volumes per cycle for any air-entry angle of a given series regardless of engine speed and scavenging pressure. The pressure-time indicator card shown in Fig. 2 was taken while using optimum air-entry angles. The engine was operating under 98 per cent of maximum power, at a speed of 1800 r.p.m. and with a scavenging-air pressure of 15 in. of Hg. Engine operation was smooth. The maximum rate of pressure rise was 50.5 lb. per sq. in. per crankshaft degree.

From the burner to the gas passes, the burning of fuel oil takes place in several chemical steps with explosion-like rapidity, each elementary step being fundamentally necessary for complete combustion

FUNDAMENTALS of FUEL OIL COMBUSTION

By E. G. Roberts

Mechanical Engineering Dept., Howard University

WHERE OIL is used as the fuel in a power plant, proper instruction of the operating personnel must be assured, or, a large percentage of the efficiency desired, will be lost. Economy in operation and good efficiency in firing emerge from a basic knowledge of the mechanics of oil combustion and applying this information continuously to boiler operations in oil fired installations.

Fuel oils of different classifications do not require different types of burners for each group, as is the usual case in the selection of coal firing apparatus for burning different grades and sizes of coal. Selection of the oil burners will depend on facts and data ascertainable at the installation. Our interest is focussed on what happens inside the furnace, and it is merely to reach that point quickly, that I mention it is good practise to atomize the oil before burning by one of the following methods:

1. Vaporizing burners comprising system under atmospheric pressure.
2. Vaporizing burners comprising system under pressures above atmospheric.
3. Mechanical pulverization on the dynamic and kinetic principles.
4. Atomization of oil by means of steam.
5. Atomization of oil by air of low, high, or medium pressures.
6. Preparing oil by means of flue gases.

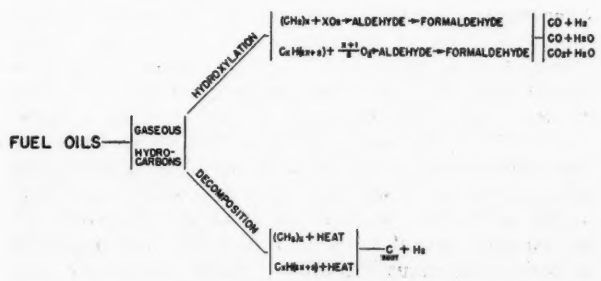


Fig. 1. Steps in the process of fuel oil combustion

Much has been said and written on the subject of these modern oil burning devices, and no doubt the matter has been treated sufficiently to be well understood.

What happens afterwards in burning the fuel oil in the combustion zone, and the theory of this oil burning is of great interest. It is this information which will be discussed presently, and from which, certain facts and conclusions will be developed.

From the time the oil flows from the heaters and is properly atomized, the following steps in the combustion process must take place as pictured in Fig. 1, regardless of its production classification, i.e., paraffin, olefines, or mixed base oils. Most of the crude distillate fuel oil used is composed of complex heavy hydrocarbons. The transformation of this complex fuel into the elementary hydrocarbons, as the first step, occurs by volatization as the temperature rises in the burner before actual combustion. This initial step is greatly facilitated by the proper oil temperature and thorough atomization and mixing with air.

The elementary fuel oils are of the saturated and unsaturated hydrocarbons, i.e. $(CH_2)_x$ and $C_xH_{(2x+2)}$ series, respectively. The saturated (paraffin) hydrocarbons, (single bond between C and H) requires more oxygen to burn in the combustion process than the unsaturated hydrocarbons by the ratio of $x + 1$ coefficients applied to the oxygen element of the equation given below. This is the distinct difference in the burning of the two classes of oils.

$$(CH_2)_x + x/2O_2 = CO + xH_2 \quad \text{Unsaturated}$$

$$C_xH_{(2x+2)} + (x+1)/2O_2 = xCO + xH_2 + H_2O \quad \text{Saturated.}$$

Thermal Decomposition versus Hydroxylation

After the initial gasification and formation of the elementary hydrocarbons, a race between two opposing reactions begin according to the graph in Fig. 1. If sufficient oxygen is present to transform all the hydrocarbons to aldehydes and eventually to formaldehydes,

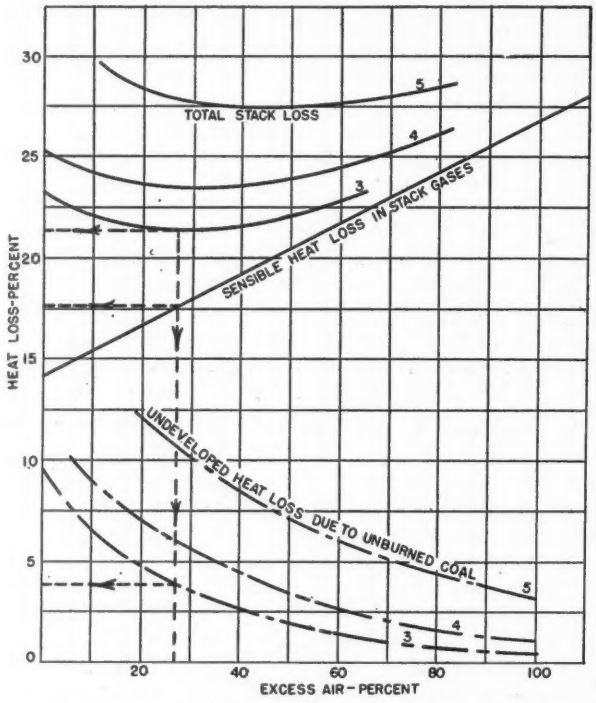


Fig. 2. Variations in sensible heat loss, undeveloped heat loss, and sum equal to total stack loss (latent heat loss is constant and neglected), with excess air. Most desirable per cent CO_2 for a given boiler furnace and fuel, with different ratios of combustion space to grate area increasing with decrease in numbers on curve. This Figure indicates general conditions; they are not accurate for the particular case. Stack temperature varies with excess air as in Fig. 4.

combustion will proceed without the formation of soot or free carbon. The heavier hydrocarbons usually undergo reactions other than simple hydroxylation, and the same is true of the lighter hydrocarbons if conditions are unfavorable for the formation of the hydroxylated compounds. Thus the heavier hydrocarbons may be "cracked" according to the previously outlined procedure, or they may be decomposed completely to free carbon (soot) and hydrogen. This latter reaction is quite rapid at high temperatures with a deficiency of oxygen. The lighter saturated hydrocarbons usually decompose more slowly than the heavier hydrocarbons.

Thus there is a race between proper combustion of the hydrocarbons and thermal decomposition. Preheating the oil and air and thorough mixing of each favors hydroxylation. If, however, the oil and air are not thoroughly mixed, after previous heating, the heat from the combustion of parts of the hydrocarbons will serve to decompose the remainder, forming soot and dense smoke. These unfavorable conditions are often found when starting the boiler, with poor draft regulation, and with extremely low loads handled in high rating boilers.

Combustion of Gaseous Fuels

In following the oxidation of the elementary gaseous hydrocarbons over the proper combustion path, the accepted hydroxylation theory is used. Experimentation has supported theory that an initial action of the hydrocarbon with oxygen occurs preliminary to final combustion, forming an intermediate unstable "hydroxylated" compound called aldehydes previous to subsequent burning to CO, CO_2 and H_2O. This action holds true at all temperatures if sufficient oxygen is present. There is no selective combustion of the carbon and hydrogen elements in the oil.

With the addition of the oxygen to the hydrocarbon, alcohol is formed first, and, it in turn, reacts with more oxygen to form aldehydes and formaldehydes. This aldehyde breaks down to immediately combustible gases CO and H_2, or the aldehyde may burn completely to CO_2 and H_2O. The name hydroxylation arises from the initial reaction giving the alcohols with their characteristic hydroxyl (OH) grouping. At high temperatures and with a mixture of gaseous hydrocarbons and some CO and H_2 formed by incomplete combustion of the formaldehydes, most all of the oxygen present will combine with the hydrocarbons.

Other considerations loom up, besides the amount of oxygen to affect the degree of completeness of the gaseous hydrocarbon combustion, such as: (1) ignition temperatures; (2) limits of inflammability; (3) rate of flame propagation.

(1) Ignition Temperature

The quicker the mixture of combustible air and gas is brought to the ignition temperature, the shorter the time required for combustion. Above the ignition temperature the completion of the chemical equation is not dependent on heat from external sources, hence, rapid combustion of the mixture will follow. Heat is generated in the combustion process in larger quantities than the dissipation of heat to the surroundings, and combustion becomes self-propelling.

Listed herewith are the ignition temperatures of the major elements found in fuel oil.

Ignition temperature of Common Compounds in Fuel Oil. (Partial List)

Paraffin Series	Temp. deg. F.	Olefine Series
Methan	1202-1383	
Ethane	968-1166	
Hexane (dry air)	909	
	1008-1018	Ethylene

Below these temperatures for the given element, the gas-air mixture will not burn freely and continuously unless heat is supplied from external sources. The velocity of combustion increases gradually but very slowly until the temperature is raised beyond this point. The ignition temperature of a gas is, therefore, seen to depend on the surrounding conditions. The term, however, as usually applied is used to designate the temperature at which rapid combustion begins. Preheating the air and oil will increase the combustion velocity at low temperatures and shorten time to reach ignition temperature, thereby, accelerating the complete combustion process.

(2) Limits of Inflammability

The explosive limits may be described as the limiting composition of a combustible gas-air mixture beyond which the mixture will not ignite and continue to burn. A gas-air mixture outside these limits, either too lean or too rich, cannot generate heat at the rate sufficient to make the combustion self-propelling. The lower limit of inflammability represents the smallest quantity of

gas, which when mixed with air will burn without continual application of heat from an external source. Above the upper limit the large amount of burnable gas acts as a diluent and again combustion cannot be self-propelling.

Burning begins at a point in the mixture by the application of heat from outside source, and the heat produced from the combustion will serve in turn to raise the remaining part of the mixture to the ignition temperature and subsequent combustion. Mixture limits are also important in recognizing the danger imminent in the potential explosive mixture handled.

(3) Rate of Flame Propagation

The speed with which a flame will travel through the gas-air mixture in the explosion range, is of great importance in burner design. It is an important factor in furnace design, and at high rates it materially increases the maximum combustion rate in a furnace for a given burner design.

The flame may ignite with a relatively slow, uniform motion, or, with a somewhat faster, accelerating, vibratory motion which may develop into a rapid explosion wave, possibly followed by detonation. Slow flame propagation is influenced by the concentration of oxygen and combustible gas in the mixture, and by the size of the enclosure where the action takes place. It is good practise to let the shape of the combustion zone conform to the outline of the flame, avoiding impingement of the flame at the rear and side walls, where contact with the refractory would create carbon deposits. When there are several burners to the boiler, it is better to let the flame fit the combustion zone, and regulate the capacity by changing tips, pressure, or by placing additional burners in service to handle the load.

Combustion is usually incomplete in an explosion wave, and for this reason plus the above considerations, it would be far more advantageous to maintain a uniform slightly accelerating flame, with the end falling just short of the rear wall and the lower tube section.

Final Stage In Combustion Process

The formaldehyde formed, depending on the amount of oxygen present, may further react in three different ways as shown in Fig. 1. Often, many of the elements formed as a result, that is, CO, H_2, CO_2, and H_2O may be found in varying quantities in the upper combustion zone.

Carbon monoxide and hydrogen under conditions of most importance in combustion work, burn separately with oxygen in the air to form CO_2 and H_2O respectively. The conditions required are: quiet burning at approximately atmospheric pressure, at temperatures between 1300 to 2700 deg. F., with combustion occurring in free space uncatalyzed by hot surfaces.

There is no danger of the carbon joining with the CO_2 in a reduction reaction because all of the carbon exists in an inert form as soot. The dissociation of CO into C and CO_2 would be of concern, but at temperatures around 2190 deg. F, or above, that are usually found in the furnace, finds that the velocity of the reaction $2CO=C+CO_2$ is very slow.

The dissociation of CO_2 and O_2 is small (0.147 per cent at 2050 deg: F. and 0.47 per cent at 2800 deg. F.). Flue gas containing 10 per cent CO_2 would be less than 3 per cent dissociated at 3000 deg. F., if there were no excess oxygen. Such a temperature is seldom, if ever, reached in oil firing in power plants. Thus, there can be little, if any free CO_2 in most cases of oil firing if there is any excess oxygen, unless the carbon monoxide and oxygen have cooled to a low temperature before combustion is completed and equilibrium established.

The low point of the total heat loss during combustion is obtained when the sum of the sensible heat loss in flue gases, and the undeveloped heat loss (heat loss due to unburned CO) is at a minimum. This condition holds only when the latent heat from moisture is constant. This low point is usually established where the excess air is a minimum and CO is less than 0.5 per cent, Fig. 2. This graph must be developed for the individual case by obtaining stack gas analysis and temperatures with varying per cents of excess air.

General Consideration of Combustion in the Furnace

Combustion of oil requires turbulence, temperature, and time. A variation in one must be counteracted by an adjustment in one or both of the others. They are interdependent as shown from the previous discussions.

Mixing of the oil and air is important. It may serve to increase the fuel quantities handled, without sacrificing any burner efficiency. It reduces the time factor in burning oil in a given combustion zone, achieving higher rates of combustion, assuming proper draft conditions.

Turbulence is started within the burner and continues into the furnace. It can be advantageously improved through the burner design and the furnace combustion zone arrangement. Turbulence of the gas-air mixture minimizes the intensely hot opaque volumes of flames, making the burning gases more transparent and promoting greater radiation to the furnace walls thus reducing the damage from flame hot spots to the walls and tubes.

Not only must the fuel oil mixture be of the correct ratio but the temperature of the oil mixture must be just right to promote burning. The Universal viscosimeter value that is best for atomizing fuel oil is 150 seconds Saybolt Universal (Fig. 3.). Also, with too low

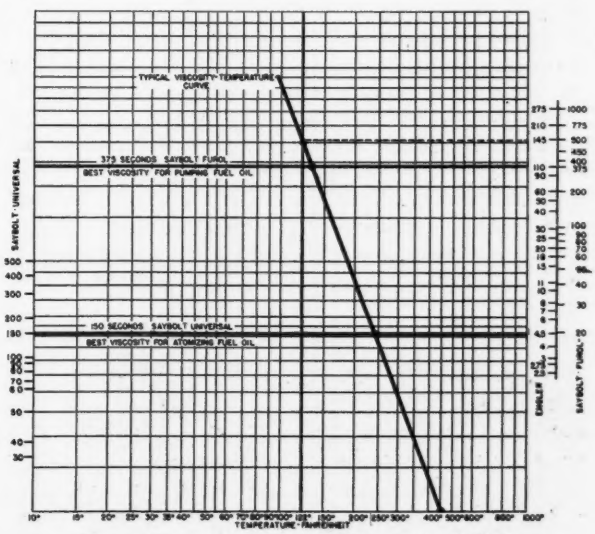


Fig. 3. Viscosity—Temperature Diagram for fuel oil

a linear velocity of the gas-air mixture issuing from the burner outlet, the rate of flame propagation will be excessive and the flame will flashback inside the burner.

High temperatures give rapid and efficient combustion, but tend to destroy refractories and tubes, and it is therefore desirable to control the shape of the flame. Frequent variation in the temperature of the flames causes thermal shock and spalling to the refractories. The conical oil spray at the burner outlet has some advantages over the flat spray in this respect. More effective use can be made of the furnace volume. and better regulation of the air supply is obtainable at different boiler ratings with the conical spray.

Between burner positions in the furnace, marked stratification of the gases will occur creating a sharp variation of temperatures across the furnace section. Burners, therefore, cannot be placed too far apart on a given line, otherwise the air stream between the burners will cool and stratify the gases, reducing the gas temperatures and retarding combustion. This condition is materially heightened at high boiler ratings.

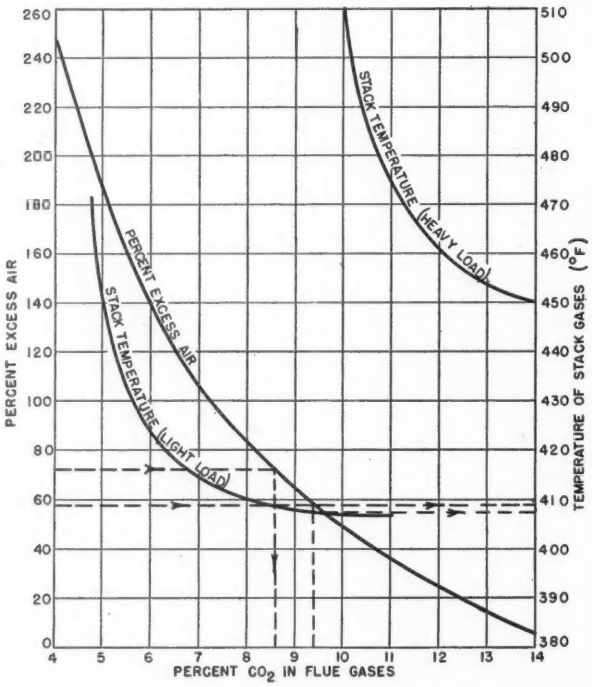

PERCENT EXCESS AIR
TEMPERATURE OF STACK GASES (°F)
PERCENT CO_2 IN FLUE GASES
STACK TEMPERATURE (HEAVY LOAD)
PERCENT EXCESS AIR
STACK TEMPERATURE (LIGHT LOAD)

Fig. 4. Effect of excess air and load on stack temperature. A set of those curves can be used with those in Fig. 2 to chart the most desirable CO_2 for any load in a specific case. General conditions are shown and are not for the specific case

Flame speed varies between dubious limits depending on the extent of mixing and the flame temperatures. The flames may be shortened by increasing turbulence with secondary air supply as the fuel oil-air stream enters the furnace. Although additional air for combustion is available to allow ready adjustment of the flame length and quality, it is better to select the burner controls and parts to provide intimate atomization of the given gas-air mixture to supply fuel feed at a uniform rate and good efficiency for the load range. Any slight adjustments of the load varying in this given range may be readily accomplished by varying air supply. Incomplete mixing of the air and fuel oil will produce a long, lazy flame giving off little heat and plenty of free carbon.

It can be seen that many factors govern the proper burning of gases, e.g., heat liberation in given volume in given time interval, spread of the oil flame, its size, shape and length, burner design, and furnace size and shape. An attempt has been made herein to outline the general process of burning with the hope that the handling of these factors, with the experience and close observation and data from the specific case will serve as a real guide to improvement in operation. Listed below are the fundamental requirements for efficient operation of oil-fired furnaces.

1. Fuel oil heaters and pumps must supply the oil to the burner at the proper temperature for correct viscosity for correct atomization as shown by Fig. 3.

2. The burner must thoroughly atomize the oil. That means selection of burner with due regard of its characteristics over a wide range of loads.

3. The atomized oil must be properly and completely mixed with required amount of air at all ratings.

4. High furnace temperature is required to sustain combustion, also a sufficient quantity of refractory surface.

5. Combustion must be completed before the gases are chilled by contact with tubes or walls. This requirement is met by ample combustion space for all ratings.

6. Heat release, a controversial consideration of great importance, on the average should equal 30,000 B.t.u. per cu. ft. per hr. at 100 per cent rating, and increase to about 80,000 B.t.u. per cu. ft. per hr. as a straight line function.

7. Flame action must not be localized on either the heating surface or the furnace brickwork.

8. Regardless of the oil-fired installation or plant conditions, it is possible to obtain desirable settings for oil-fired boilers for various loads by using the Orsat to establish specific conditions as in Fig. 2.

9. The appearance of the flame is an unsatisfactory method of adjusting the fuel oil-air mixture for different loads.

10. Keep the air leakage down to a minimum in the setting through regular inspection of the setting.

11. Keep the excess air quantities down. The general effect of excess air is shown in Fig. 4, with the attendent variation in the stack temperatures.

Turbine Classification

CLASSIFICATION of steam turbines of 7500 kw. and over, under construction in the Westinghouse shops during the year 1937 shows interesting trends toward higher speeds, pressures and temperatures. The accompanying table shows the distribution in number of units, actual kilowatt capacity and percent capacity.

Classification of Westinghouse steam turbines of 7500 kw. and over for 1937

TYPE	NO.	CAPACITY, KW.	% OF CAPACITY
Condensing	19	525,000	69
Non-Condensing	7	237,500	31
SPEED			
1800 (1500) rpm.	7	250,000	33
3600 rpm.	19	512,500	67
INLET TEMP.			
Up to 750° F.	10	232,500	30
751° to 850° F.	8	247,500	33
851° and higher	8	282,500	37
INLET PRES.			
Up to 450 lb.	9	220,000	29
451 to 650 lb.	6	155,000	20
651 lb. and up	11	387,500	51

Part XXII

Tubes! Small tubes, large tubes; short tubes, long tubes; thin tubes, fat tubes; glass tubes, metal tubes; air cooled tubes, water cooled tubes; high vacuum tubes, gas filled tubes; glow tubes, regulator tubes, cathode ray tubes; diodes, triodes, tetrodes, pentodes, hexodes, heptodes, duodiodes, tubes of all kinds, for every conceivable use and in any desired size. This is the first of two articles discussing the various commercial types available. A second article on this particular phase of the subject will appear in the March issue.

ELECTRON TUBES— Principles and Applications

By A. W. Kramer

IN 1920, less than two decades ago, there was only one type of thermionic tube in existence. This was the simple triode, used primarily in telephone work and in the simple wireless telegraph receiving sets of that day. It was made in only a few sizes and was rather fragile in its construction; it was easily damaged and not always stable in its performance.

In the current edition of the Wiley Electrical Engineer's Handbook there are listed 441 different types and sizes of electron tubes! This, as nothing else can, indicates the astonishing progress made in our knowledge of and application of electronics. Today there are available tubes in every variety of size and for every conceivable purpose. There are small tubes, large tubes, glass tubes, metal tubes, high vacuum tubes, gas filled tubes, phototubes, cathode ray tubes—tubes ranging in size all the way from the FP 54 capable of measuring a flow of 60 electrons per second to water cooled giants such as the AW 220 which can dissipate 125 *kilowatts* at the plate at normal rating. In short, there are no end of tubes.

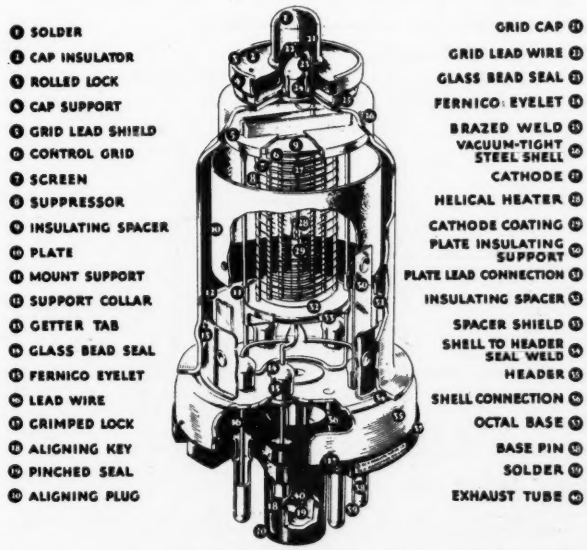


Fig. 1. Internal structure of an all-metal electron tube (Drawing, courtesy R.C.A.)

Until about four years ago, all tubes except the water cooled affairs used for high power radio transmitters were made of glass. Today tubes even in the smallest size are made either of glass or of metal and all tubes whether of glass or of metal are rugged enough to withstand almost any industrial application.

The tremendous number of tube types available today, however, is likely to appall the neophyte in electronics who wants to pick out the most suitable tube for a particular purpose. Apart from the very number available, many tubes have quite similar characteristics and unless one is more or less familiar with the particular advantages or limitations of certain tubes, the abundance of types available is liable to be more of a detriment than an advantage.

So in this article we will consider, somewhat informally, the various types of tubes available and the methods by which they are classified. The situation really is not as complicated as it appears. It is true, there are a large number of tubes available but there is a great deal of duplication between different cathode-voltage groups so that actually there are not as many different kinds of tubes as might appear from a first impression of the tube listings. For example, the 01 A triode amplifier which was one of the first tubes to go into standard commercial production, has a filament-

cathode operating at 5 v., a plate voltage rating of 90 to 135 v., a grid bias of —4.5 to —9.0 v. and a mutual conductance of around 1100 micromhos. Close inspection of tube data tables will reveal that there is another tube available with practically these same characteristics except that the filament voltage instead of 5 v. is 2.0 v. This is the type 30. In other words, the 30 is the counterpart of the 01 A in the 2.0 v. battery-tube classification. Further inspection of the tube data tables will show that there is still another tube available with the identical characteristics of the 30. This is the 1H4G, a 2.0 v. battery tube with an octal base.

Now to one whose knowledge of electron tubes is based largely upon what has been published in these articles, all this no doubt is very mystifying; octal

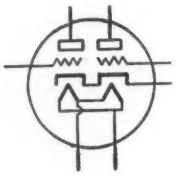


Fig. 2. Diagram of a twin triode using indirectly heated cathodes

bases, mutual conductance, cathode-voltage groups, battery tubes, etc., what is the meaning of all these terms? Very few of these terms have been covered thus far, but have patience, we will endeavor to explain them.

The classifications of tubes as they exist today are not perfect but in the nature of things they are not bad and considering the rapid development of the art, the standardization is quite remarkable. Whatever lack of standardization exists today is due only to the extremely rapid development of the art.

Neglecting those early tubes which were built for relatively high power radio transmitting purposes, practically all of the first tubes had a simple filament cathode operating at 5 v. Shortly afterwards a few tubes were developed with filament voltages of 3.3 v., suitable for operation from 2 dry cells. All these tubes were suitable for use only with a direct-current filament supply and they were all of the directly heated cathode type, that is, the filament itself was the cathode.

The next development was the alternating current type of tube, tubes capable of being operated from an alternating current filament supply. For this, with directly heated cathodes, a low filament voltage was necessary, and so, a line of 2.5 v. tubes was developed.

As explained in an earlier chapter[1] cathodes are of two types, directly or indirectly heated. When directly heated cathodes are operated on alternating current, the cyclic variation of the current and voltage causes electrostatic and electromagnetic effects which vary the plate current of the tube at the supply frequency (in most cases 60 cycles) and thus produce a hum in the output, that is, when used in radio-receiver circuits. The electrostatic and electromagnetic variations are reduced at lower voltages and so the first so-called a.c. tubes had directly-heated filaments operating on 2.5 v. A more effective way of reducing the hum, however, is by the use of an indirectly-heated cathode, consisting of a thin metal sleeve or thimble, coated with electron emitting material enclosing a tungsten wire which acts as a heater. The heater brings the cathode thimble to the proper temperature to cause electron emission. This type of cathode is also known as the equipotential cathode, since all parts are at the same potential. The cathode is not ordinarily electrically connected to the heater inside the tube, the terminals of the two parts being brought out to separate base pins.

[1]Part III. April 1936, p. 230.

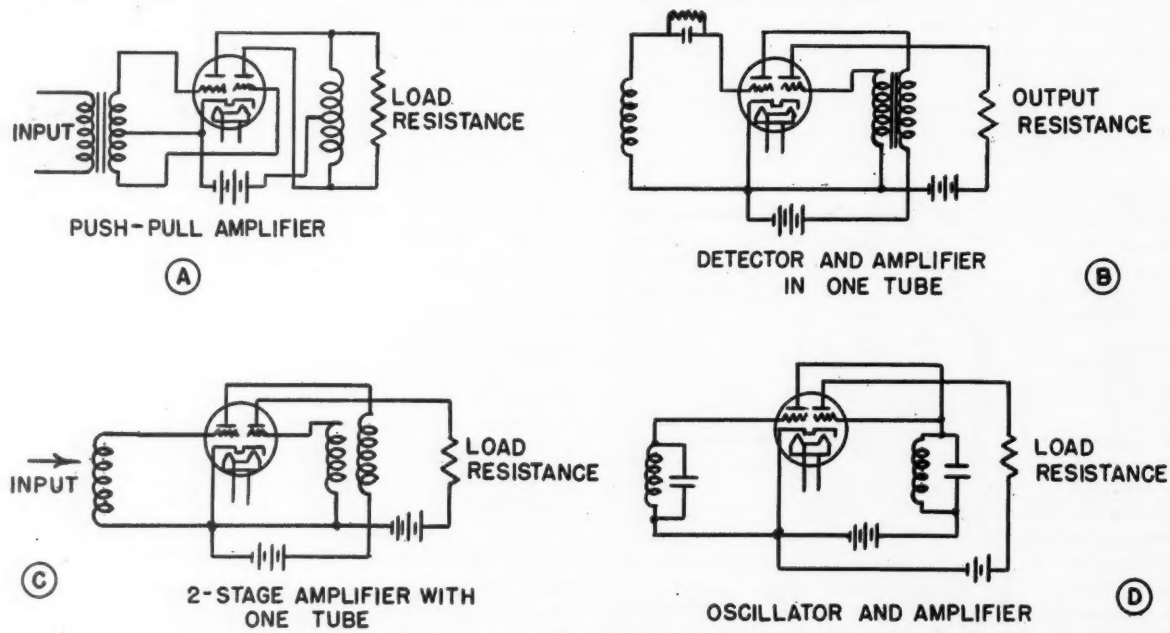


Fig. 3. Various applications of the twin triode

A, shows a push-pull amplifier using a single tube. In the push-pull amplifier two tubes are ordinarily used with their grids and plates connected to opposite sides of a balanced circuit. The cathode returns are made to the midpoint of the input and output transformers or resistors. In this case, the circuit is exactly the same except that the two tube elements are incorporated in a single envelope. B, C and D are self evident; in each instance the elements of what would ordinarily require two tubes are incorporated in one tube. These diagrams are presented only to indicate principles, not actual circuits.

The development of the indirectly heated, or heater type cathode as it is known, eliminated the necessity for low filament voltages, and most of the tubes using this form of cathode were designed for use with a 6.3 v. filament supply. Today, except for a few special types, practically all radio receivers are constructed for operation from alternating current using tubes having 6.3 v. cathode ratings, this voltage being regarded as standard. There is also available a standard line of battery tubes for operation at 2 v. Nearly all of these have directly heated cathodes.

More recently, a line of entirely metal tubes has been developed. These were made practical by advances in electric welding methods which in themselves were brought about by the use of electron tubes to provide

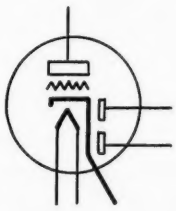


Fig. 4. A duplex diode triode

accurate control of the welding operations. In the manufacture of these metal tubes, vacuum tight welds requiring current flows of as much as 75,000 amperes are made in a fraction of a second. Another factor contributing to the development of these tubes was the use of Fernico metal, an alloy which seals readily to certain special kinds of glass. The use of Fernico eyelets and glass bead seals, as illustrated in the cut-away drawing of a metal tube in Fig. 1 permits of many advantageous innovations in tube assembly.

The advantages of metal tubes probably lie mostly in manufacturing methods, although in certain applications the superior shielding afforded by the metal shell is an important factor. They are also more compact than glass tubes. From an industrial application standpoint however, metal tubes probably have an advantage over glass tubes that does not hold in the communication field. The electron tube, it must be remembered, was a baby born and nurtured in the communication field. The communication engineer has always been concerned with rather delicate apparatus, and the idea of a glass tube never held any misgivings for him. He took to it naturally with all the poise and confidence in the world. To the industrial electrical

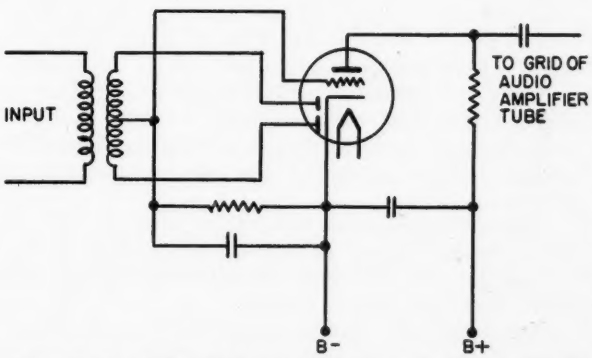


Fig. 5. Duplex diode triode used as a full wave diode detector and amplifier in a radio receiver circuit

engineer, accustomed to working with ponderous equipment, the idea of a glass tube in a factory was the inverse of the bull in a china shop and he developed a shyness toward the use of tubes which persists to this day. Such fragile things as glass tubes had no place in his philosophy though Heaven knows he used glass incandescent lamps with no inhibitions. It is in this respect that metal tubes have a distinct psychological advantage. Even though these tubes are only little more rugged than glass tubes the psychological effect of a solid metal shell goes a long way toward get-

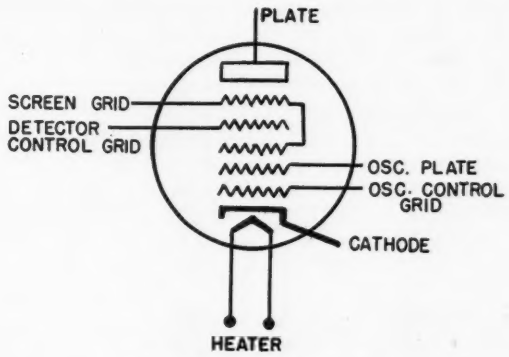


Fig. 6. The pentagrid converter

ting around the average factory man's inhibitions against tube apparatus. All metal tubes have heater cathodes operating at 6.3 v.

It is evident now that while tubes can be classified according to their function, as rectifiers, or amplifiers or more accurately by the number of elements they contain, such as diodes, triodes, tetrodes, etc., another useful classification is obtained when they are grouped according to their filament or heater voltages and that is how they are classified most frequently. Thus, tubes will be grouped as 6.3 v. low power tubes, 2.5 v. low power tubes, 2 v. battery tubes, metal tubes, etc. Rectifiers and high power tubes are usually grouped by themselves, as diodes, triodes and tetrodes.

As listed in the Wiley Electrical Engineers' Handbook, they are grouped in 19 classifications according to function. Thus group I lists low power high vacuum rectifiers, a group which itself is divided into half wave and full wave rectifiers. Group II lists high-power high vacuum rectifiers which are all of the half wave type. Group III lists gas filled rectifiers, also sub-divided into half and full wave tubes. And so on, a complete list of these groups is shown in the accompanying tabulation. There is of course nothing standard about this classification and various other groupings are possible, but it does show the wide variety of functions to which electron tubes can be adapted.

As pointed out previously, all this is no doubt confusing to a person who has not lived with electron tubes to a certain extent. Indeed, even those who are familiar with electronics find the constantly growing list of tubes available something of a problem. The reader who has followed this series of articles thus far is familiar with the meaning of many of the groupings in the accompanying tabulation but there are others which will sound quite strange. The terms Class B triodes and Class C Power Amplifier triodes, for ex-

ample, have not been touched on in these articles, nor have a number of the others. This need not cause discouragement, however, many of these terms have application only in communication work, in circuits involving voice or voice-modulated high frequencies. We need not discuss these things in detail here, but a few words of explanation may remove some of the element of mystery.

Class A, B, and C are terms used to express the different methods used in operating amplifiers. This is largely a function of the way the tube is operated with respect to grid bias although certain tubes are better adapted to certain kinds of operation than others. A Class A amplifier is one in which the shape of the output wave is a faithful reproduction of the input wave. A Class B amplifier when operated correctly will also provide an accurate reproduction of the input voltage at the output but it has a higher plate efficiency[2]

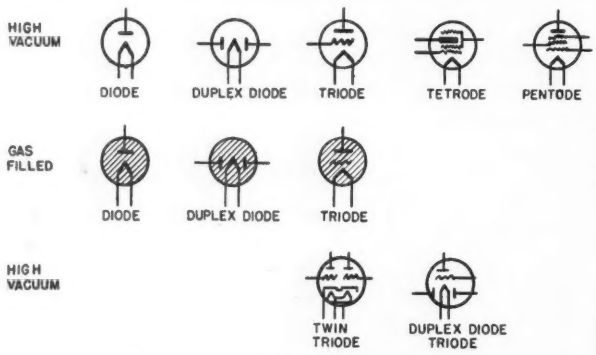


Fig. 7. The most commonly used electron tubes

than the Class A. A Class C amplifier has relatively high distortion but also very high plate efficiency. These methods of operation will be explained in greater detail in a subsequent article.

Such terms as duodiode, duodiode-triode, etc., as appear in the tabulation obviously refer to combinations of diodes or triodes in a single glass envelope. The tubes considered thus far have been diodes, triodes, tetrodes, and pentodes. It is quite possible to combine two or more of these types in one tube. Thus, a duodiode or duplex diode is a tube with two diodes combined in one tube, represented by the full wave rectifier. A twin triode is one with two triodes in a single tube. Such a tube is shown in Fig. 2. It can be used as a detector and a one stage amplifier, as a two stage amplifier as an oscillator and amplifier, as a push pull amplifier as well as in other ways.

Such tubes are called multi-purpose tubes and while they can be used to some extent in industrial applications they were devised primarily to do special work in radio receiving circuits. The simplest are the duplex diodes and twin triodes already mentioned. To add the functions of diode detection and automatic volume control in radio receivers to that of amplification a number of types are made in which two diode plates are placed near the cathode but not in the amplifier-portion structure. The diagram for such a tube is shown in Fig. 4 which is a duplex diode triode. A typical tube of this type is the 55 used as a full wave diode detector and amplifier in Fig. 5. The two diodes are used as a full wave detector (rectifier) feeding the triode as an audio frequency amplifier. These matters are of interest largely to radio engineers but they are presented here to show how flexible the electron tube is in its application.

[2]By plate efficiency is meant the ratio of a.c. output power to steady d.c. input power. The plate efficiency of the Class A amplifier is relatively low—from 20 to 35 per cent at full output depending upon the design of the tube and the operating conditions.

Classification of Electron Tubes according to function.

1. Low-power high vacuum rectifiers
   A half wave
   B full wave
2. High-power high vacuum rectifiers
   All half wave
3. Gas restifiers
   A half wave
   B full wave
4. General purpose triodes (low power)
   May be used as detector, oscillator, voltage and low-power amplifiers
5. General purpose triodes (intermediate power)
6. Class B triodes
   Special Class B power amplifiers—triodes and duotriodes operated with no bias on control grid
7. Class B and Class C Power-Amplifier Triodes (intermediate power)
   Used particularly for Class B and C amplifiers and oscillators
8. Water-cooled Triodes
9. Internally screened voltage-amplifier tetrodes and pentodes
10. Unscreened Power-amplifier tetrodes and pentodes
11. Internally screened power-amplifier tetrodes and pentodes
12. Duodiode-triodes and duodiodes
13. Duodiode-pentodes and triode pentodes
14. Special five-grid oscillator-Modulators and frequency converters
15. Special ultra-high-frequency oscillators
    A split-anode magnetrons
    B Electronic oscillators
16. Electrometers
17. Current regulators
18. Voltage regulators and surge protectors
19. Ionization gages

Another tube of great usefulness in radio receiver work is the so-called pentagrid converter, a tube which as its name indicates has five grids and which combines the functions of a detector and oscillator in superheterodyne receivers. It is shown diagrammatically in Fig. 6. In the superheterodyne receiver, the incoming signal frequency is converted to a lower (intermediate) frequency by combining it with a locally generated high frequency and then amplifying this resulting intermediate frequency by ordinary amplifiers. The local frequency in the early receivers was always generated by a separate local oscillator, the output of which was combined in the first detector tube with the incoming signal frequency. With the pentagrid tube both of these functions, i.e., the generation of the local frequency and detection are combined in a single tube. The two inner grids serve as control grid and plate of a small triode oscillator, while the fourth grid is the detector control grid. The third and fifth grids are connected together to form a screen grid which shields the detector control grid from all other tube elements. The pentagrid converter eliminates the need for special magnetic or electrostatic coupling devices in the circuit since the mixing of the two frequencies is done electronically in the tube.

These few examples will suffice to show that an almost endless variety of combinations is possible and that as the need for other combinations of functions arises, new tubes can be devised.

Tubes are also classified regards their characteristics. There are, for example, sharp cut-off and vari-

(Continued on p. 121)

It is often desirable or necessary to operate a group of 2 or more motors so that they start and stop simultaneously or in definite sequence. In this article the author describes several of the more simple circuits whereby this may be accomplished.

INTERLOCKING MOTOR CIRCUITS

By C. C. HERMANN

THE OPERATION of more than one motor in an interlocking circuit arrangement is a common problem encountered in manufacturing plants. The necessity for the operation of motors in this manner is found in connection with such machines as automatic drilling and tapping machines, multiple drills, forming and reaming operations. It is also found in connection with conveyors, molding machines and many other kinds of manufacturing equipment.

The simplest kind of interlocking operation is that shown in Fig. 1 in which we have two motors A and B which are direct connected on the same machine and must start and stop simultaneously. A single push button 1 is used for the operation, 1a being the start button and 1b being the stop button. The power source is shown at C and is 440 v., 3 phase, 60 cycle alternating current. The starters are of the across-the-line type illustrated diagrammatically at D and E. Each motor is provided with a fused safety switch F and G for the purpose of protection of the branch circuit to each motor and for the protection of the workman should it be necessary to work on the motor or starter. Besides the fuse protection each starter is provided with inverse time limit relays, 2 for overload protection, these relays being inserted in the motor operating circuit in two phases. In case of a sustained overload these relays would trip, opening the motor operating circuit and stopping the motor. Since they are usually of the thermal type they may be reset and the motor thrown across the line almost immediately thereafter. If the overload re-occurs the relays again function. These relays may also be obtained in the oil dash-pot type, however, their function and operation is the same as mentioned above. Both types must be reset manually by means of a lever on the starting box.

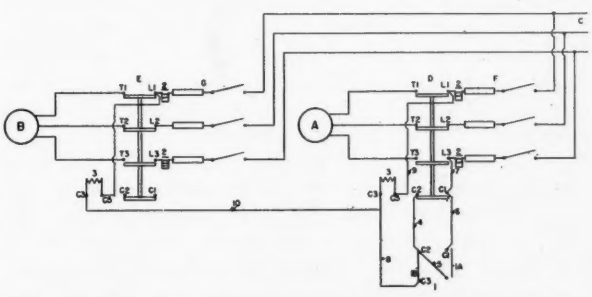


Fig. 1. The simplest kind of interlocking circuit is one in which two motors start and stop simultaneously

The line side of the starter consists of the three line contacts L1, L2, and L3 as marked and the running side consists of the three running contacts T1, T2 and T3. The starter is provided with a contact arm electro-magnet coil 3 which, when energized closes the contacts so that the motor circuit is closed starting the motor. One side of the coil 3 is connected to the line contact L1 and the other side of the coil is connected to the terminal C3 of the stop button 1b. The stop button is normally closed as shown so that terminals C3 and C2 are connected through the button also terminal C2 of the button and terminal C2 of the magnetic starter are connected together by the jumper 4. The start button is normally open and when depressed closes the gap between terminals C1 and C2 by means of the jumper 5. Also terminal C1 of the start button is connected to terminal C1 of the starter by the jumper 6. Terminal C2 is in turn connected to line terminal L3 by the jumper 7. It is obvious then that by depressing the start button 1a current will flow from line terminal L3 through C1 of the starter auxiliary contact, to C1 of the start button, through the bar of the start button and jumper 5 to terminal C2 of the stop button side through the stop button switch to terminal C3, through the jumper 8 to terminal C3 on the starter through the magnetic coil 3 to the line terminal L1 by way of the jumper 9 thus completing the circuit. The coil 3 being thus energized closes the switch so that the fourth contact is made up between terminals C1 and C2 of the starter thus forming a holding circuit. The start button can now be released and the contactor will hold in. To release the contactor and stop the motor it is only necessary to depress the

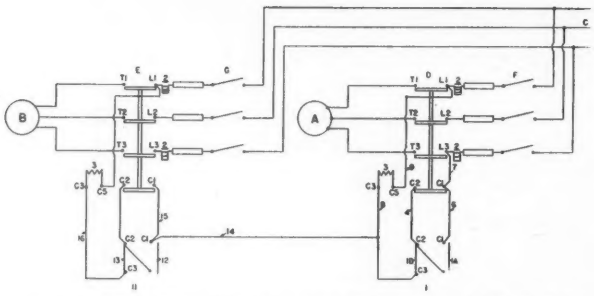


Fig. 2. Circuit designed for operation of two motors interlocked but started at different times

stop button 1b thereby interrupting the magnetic circuit de-energizing the coil 3 which allows the contactor to drop out. The motor operating circuit is thus interrupted and the motor stops.

To start the second motor at the same time as well as stop it at the same time requires only that the C3 side of its coil 3 be connected to the C3 terminal of the stop button 1 by means of the jumper 10. All connections on the starter are made identically the same as described above except that the fourth contact C1 and C2 of this starter are not required.

When the Motors Start at Different Times

In Fig. 2 is shown a circuit designed for the operation of two motors in interlocked relation to each other but started at different times, that is motor B cannot be started until motor A is in operation. Starter D and push button 1 for motor A is wired in identically the same manner as in Fig. 1. In this case, however, motor B is provided with its own push button station 11, its start button 12 and stop button 13. The terminal C1 of the start button is wired to the terminal C3 of stop button 1b by the jumper 14. A jumper 15 is inserted between terminals C1 of the start button 12 and terminal C1 of the contactor E. The jumper 16 is placed between terminal C3 of the magnetic coil 3 of starter E and terminal C3 of the stop button 13.

Now it is observed that after motor A has been started it is possible to depress start button 12 and obtain a flow current through coil 3 of starter E thereby closing contactor of starter E but not before. Therefore motor B cannot be started until after motor A is started. Motor B can be stopped independently of motor A as long as the latter motor is operating, however, if Motor A is stopped then Motor B will also stop since its magnetic circuit would be interrupted.

Three Motors Starting in Sequence

In Fig. 3 we have the gang hook-up consisting of three motors A, B and C which are to be started in sequence by their respective start and stop buttons 1, 2 and 3. The power source is 440 v. 3 phase 60 cycle by means of the three wire power main 4. In some installations, such as shown in the previous Figs. 1 and 2 the start and stop button service is taken direct from the 440 v. service without reduction in its initial voltage, however, in this case the push button service is reduced to 110 v. by the single phase transformer 5. In many installations the push button service is taken off the 110 v. lighting or hot-plug circuit. This latter scheme involves running two separate lines to the motor starting switch which is not always convenient or necessary.

Each motor branch is protected by a fused safety switch 6 the line side of which is connected to the main as indicated. This method of connection of motors to the main presupposes that the conductors from the main to the safety switch comply with the prevailing code which in some cities permits a change in wire size of one while in others the size may be changed by two sizes. Of course the size may be changed at will provided fuse protection is provided at the junction with the main. In other words if the three motors are each 5 hp. having a full load plus over load rating of 115 per cent and allowing 400 per cent for starting current the fuse rating would be 30 amp. This would require number 8 wire size in the motor circuit and, if the three motors constituted the total load on the main the main wire size would be number 4. To hold to this arrangement would require a fuse at the junction of each branch with the main. The proper connection would be made by the use of number 6 wire in the branch circuit.

The motor starters 7, 8 and 9 would be of the across-the-line type with magnetic contactor. All terminals of the various starters are designated with like markings to facilitate following through. The magnetic coil of starter 7 is shown at 10, that of number 8 at 11 and that of number 9 at 12. The inverse time limit over-load relays are shown at 13 and 14 on starter 7 and in similar positions on the other two starters. It is noted that the relays, which may be of the dashpot or thermal type have their heaters in series with two phases of the motor leads.

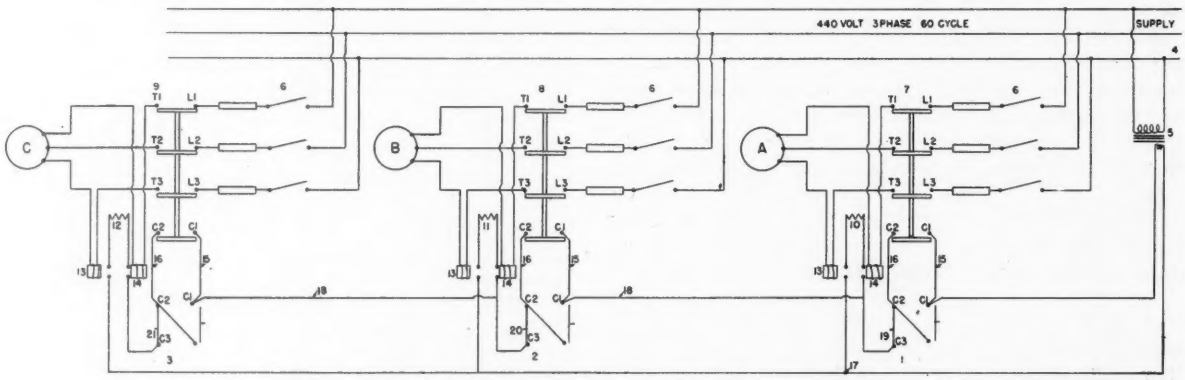


Fig. 3. Gang hook-up of three motors arranged for starting in sequence

Referring to motor A and starter number 7 the fourth contact C1 and C2 is provided with jumpers 15 and 16 to like terminals on the push button 1. One side of the secondary of the transformer 5 is connected to the C1 terminal of the start button. One leg of the magnetic coil is connected to terminal C3 and the other leg of the coil is connected to the other side of the transformer secondary at 17. Obviously when the start button is depressed the current path through the coil 10 is completed closing the contact and making up the hold in circuit through the fourth contact C1 and C2 of the starter 7.

Now referring to motor B and starter 8 all connections are identical with the foregoing except that the jumper 18 is placed between start button terminal C1 and terminal C3 of the stop button of the preceding starter. Likewise referring to motor C and starter 9 this same jumper 18 is used between the same terminals as in the preceding case.

It is obvious that no current path through the coil 11 can be completed unless starter 7 is first closed and likewise no current path can be completed through coil 12 unless both starter 7 and 8 are closed. Therefore the motors must be started in sequence starting with A and then B and last C. Depressing stop button 19 on starter 7 will interrupt the magnetic circuit of all starters and all motors stop. Motor B can be taken off the line by depressing stop button 20 and leave motor A run but motor C will stop with motor B because the magnetic circuit beyond B is also interrupted. Motor C can be taken off the line by depressing stop button 21 and leaving motors A and B run. It is obvious that any number of motors can be started in sequence and stopped in reverse sequence by elaboration of this hook-up. It is one of the most popular group connections encountered in machine shops.

Electron Tubes

(Continued from p. 118)

able mu (μ) types. In the sharp cut off type of tube, the amplification factor[3] is practically constant regardless of the grid bias, while in the variable mu type the amplification decreases as the negative bias is increased.

The principal point we want to emphasize in this article is that the complexity inherent in modern tube data need not cause discouragement to the beginner in electron tube work. For most industrial applications only a few simple types are used and they are involved in relatively simple circuits. The types of tubes indicated in Fig. 7 are all that the average industrial user need be concerned with and some of these will find application only rarely. One should, however, be familiar with different tube types and their characteristics and one should study the tube data from time to time as it is released. For general information, the Radio Corporation of America publishes a tube manual which sells at a low price and presents up-to-date data on the most commonly used tubes. A great amount of information is available in various handbooks, and a dozen or more good books are available which deal with tubes in various ways. No attempt will be made in this series to present detailed data on tube characteristics as that is all easily available elsewhere.

[3]The amplification factor of a tube is the measure of the amplification of which a tube is capable. It is designated by the Greek letter (mu) and is expressed as the ratio of plate, voltage change required for a given change in plate current, to the grid voltage change necessary to produce the same change in plate current.

Modern Turbines

(Continued from p. 108)

maximum and minimum flow. In general, the maximum section flows are determined by the maximum extraction flows required for the particular application; and the minimum section flows are fixed by the cooling steam requirements. The significance of the limits for double automatic extraction turbines is explained by the accompanying tabulation. (p. 108).

Note how simply the chart for double automatic extraction turbines, Fig. 8, may be read. If there is no high pressure extraction the left hand chart is ignored and the throttle flow is read just as if the turbine had single automatic extraction. With extraction from both openings an additional step in reading includes the increase in throttle flow needed for various high pressure extraction flows.

One important thing should be learned from this study of the different performance charts with their limits. Complete information must be furnished the manufacturer on which to base the design. Suppose for example that a manufacturer was given all of the maximum conditions to be met but none of the minimums. It will be recalled that the maximum exhaust section flow is determined by the maximum load to be carried with the minimum extraction. With no minimum specified the manufacturer would normally assume that full load must be carried with *no* extraction. But suppose that for this particular application there must always be sizable extraction flows. Then the exhaust section might be designed much larger than would ever be required; it would never be operated at its most efficient flow, and quite possibly a larger and more expensive condenser than was needed would be bought. If, on the other hand, the manufacturer had been provided with complete information the turbine could have been designed to favor the normal operating conditions yet still have capacity to meet any extremes in the range of expected operation. Proper application of extraction turbines is dependent on the accuracy and completeness of the information on which their design is based.

The performance charts described in this article are representative of the usual charts furnished for all types of turbines. In every case they consistently follow the basic Flow versus Output Chart, Fig. 1. However there are numerous other forms in which the same data could have been expressed. It is not uncommon, for example, to see performance charts for single automatic extraction turbines plotted Extraction Flow versus Throttle Flow with lines of constant output. In most cases these other forms are not as easily usable as the forms described, and when encountered it is sometimes advantageous to replot the chart in one of the basic forms described.

Steam Flow versus Output charts outweigh in relative importance all other expressions for turbine performance. But certain other types have special uses which makes them well worth understanding. In next month's article the most important of these other performance charts will be explained.

BRUSH WEAR

Tests show that where the atmosphere can be controlled brush wear is negligible*

ONE OF THE MOST IMPORTANT wear considerations in the generator and other rotating electrical apparatus is that of wear of carbon brushes on slip rings. For some time it has been recognized that rapid wear of the elements involved in current collection by sliding contact was frequently due to lack of moisture in the surrounding atmosphere. Many such occurrences, it has now been established, are coincident with a fall in humidity. In fact, when the moisture content of air drops below 2 grains of moisture per cubic foot of air, the danger line is reached and rapid wear may occur. Fig. 1 shows the relationship between the humidity of the air and the coefficient of friction and rate of wear of carbon brushes when operating on a metal slip ring. This test was made in our laboratories, where it was possible to control the humidity of the room air, and clearly shows the relationship existing between these two factors and shows the small time interval between a change of humidity and a change in the rate of wear of the members in sliding contact.

One theory has been advanced to explain why friction and wear is increased with decreased humidity. This theory is that the poorer lubricating qualities of the drier surfaces naturally increase the friction. The above principles have been accepted as controlling the performance of slip rings and brushes as used on turbo generators and other electrical machines, and in many actual installations humidifiers are used to prevent the moisture content of the cooling air from dropping below a definite minimum value.

The curves of Fig. 2 illustrate the results of a test made using our standard carbon brush on the slip rings of hydrogen-cooled condensers. As these brushes normally operate on steel rings in service, this test was made on steel rings. For the first 50 hr. of the test the brush operated in air and as indicated by the slope of the curves it can be seen that the rate of brush wear was great. The slope of these curves at any point in an indication of the rate of wear of the brushes. At the end of 50 hr. operation in air the air was replaced by hydrogen and as shown by the curves, the rate of brush wear suddenly decreased. During the next 1300 hr. these brushes operated in a hydrogen atmosphere and the total wear was so small as to indicate a brush life of 130 yr. for the positive brushes and 50 yr. for the negative brushes.

At the end of about 1900 hr. air was again introduced around the rings and as the curves indicate, the brush wear increased suddenly, being especially high on the negative brushes. After a short run in the air brushes were again allowed to run in hydrogen and the brush wear decreased.

These curves explain the almost unbelievably small wear observed on the brushes of synchronous condensers in the field. This same long brush life should be obtainable on the slip rings of turbo generators when these machines are operated in hydrogen.

The test rig on which these tests were made used rings 9½ in. in diam. running at a speed of 1725 r.p.m. (peripheral speed about 4500 ft. per min.). The current density was 40 amp. per sq. in. (direct current).

The curves of Fig. 3 indicate the results of a similar test on some metal graphite brushes. In this test the brushes were operated first in air, in hydrogen, in nitrogen, in hydrogen again, in oxygen, in hydrogen again, and finally in carbon dioxide.

It is interesting to notice how low the brush wear is when the brushes operate in any one of the non-oxidizing gases. This is especially true in the last two tests, the one in hydrogen and the other in carbon dioxide, where all of the moisture was taken out of the gases used. The curves indicate that by the choice of the proper atmosphere one could increase the life of metal graphite brushes as much as thirty times over that obtained in air.

* Taken from a paper Wear From the Power Standpoint presented by N. L. Mochel of Westinghouse E. & M. Co. before the A. S. T. M. Wear Symposium.

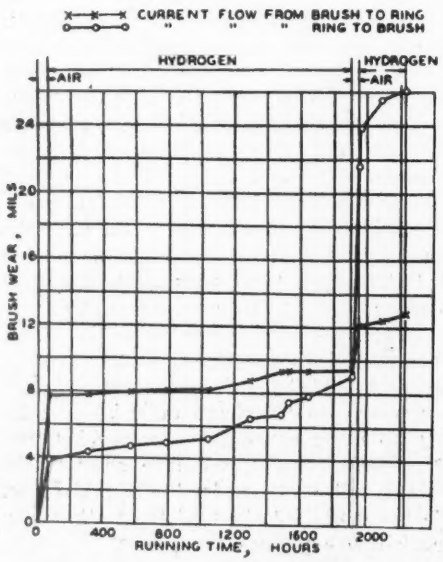


Fig. 2. (Left) Wear of a carbon brush on steel rings in hydrogen and air

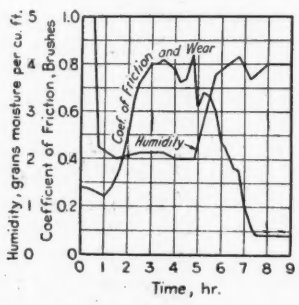


Fig. 1. Effect of humidity on friction and wear of carbon brushes and slip rings

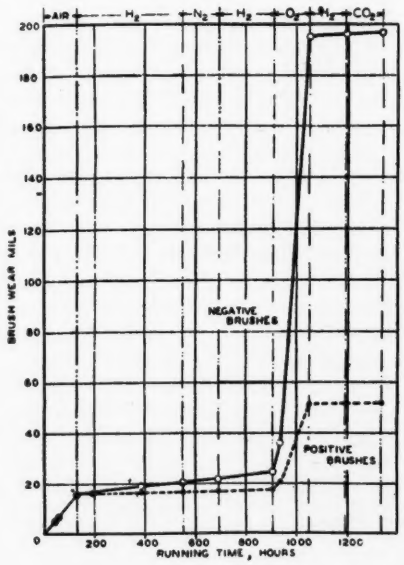
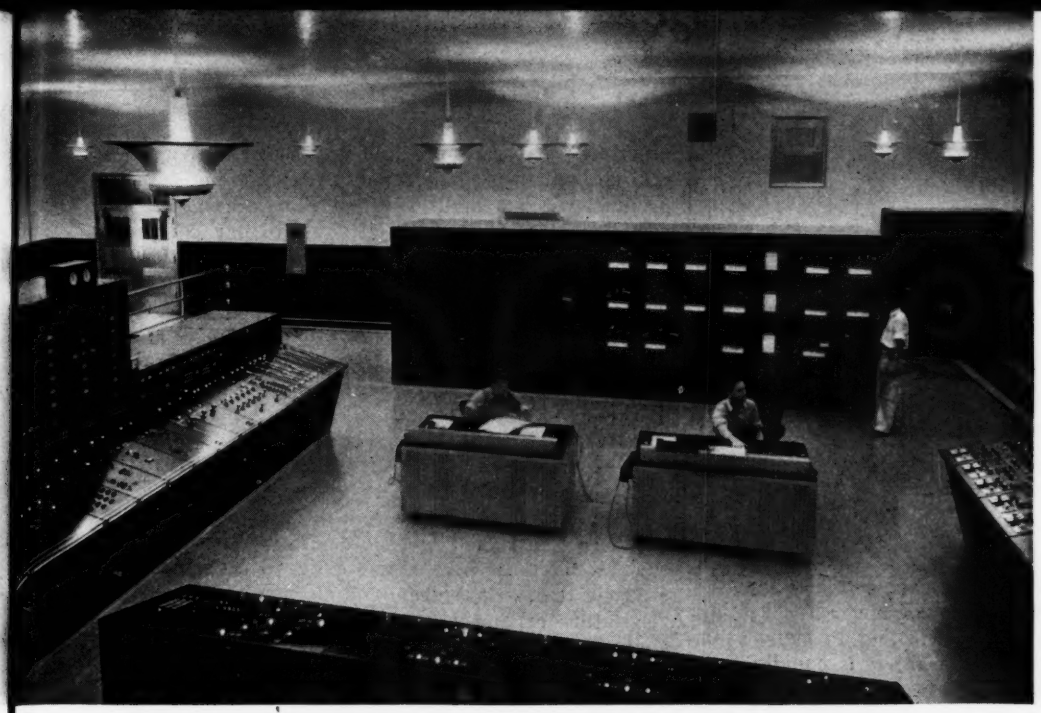


Fig. 3. (Right) Wear of metal-graphite brushes in various gases



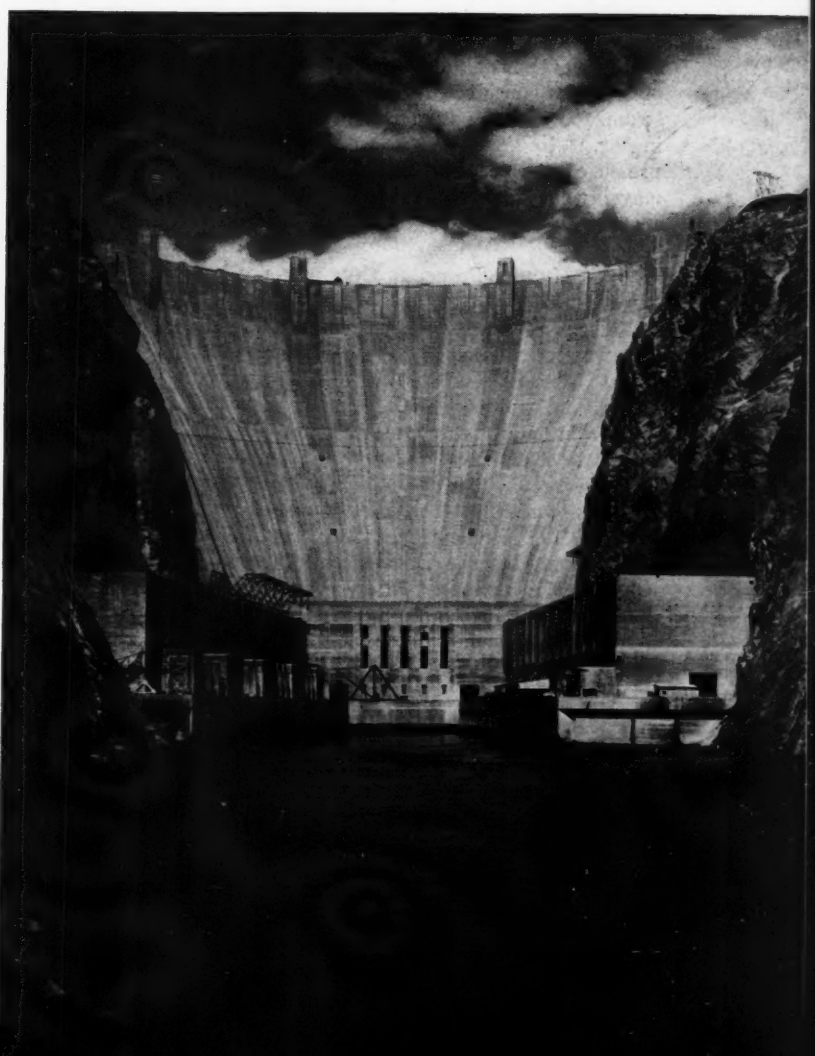
Photos courtesy Bureau of Reclamation Department of the Interior.

BOULDER DAM IN OPERATION

DURING the six years since 1931 during which Boulder Dam has been under construction we have presented many photographs showing progress as construction proceeded; so to those who have followed the growth of this famous project in this publication and in others, the details and general features have long become familiar. One has scarcely to glance at a picture of anything connected with Boulder Dam twice to know where it was taken.

On this page we present two recent views showing the project in its completed state. The one of the dam will be more impressive, perhaps, when it is known that the two power houses, one on each side of the river are twenty stories high. The water behind the dam has risen to more than 400 ft. above the level of the water in the tailrace.

The upper view shows the main control room. These panels control the 82,500 kv-a. generating units and the transmission of the electrical energy to Los Angeles 250 miles away.



To Generate or Not to Generate Power

By Edmund E. Higginson

SURVEYS PUBLISHED from time to time show remarkable savings by the use of purchased power and the independent generation of steam for heating and process use. While it is true that in many cases savings may be made in this way, it is equally true that in other cases savings may be made by generating all the power used or by generating a portion of it and purchasing the balance. The proper course of action is dictated not only by the quantity of power and steam used throughout the day but by the shape of the load curve as well. On a 24 hr. basis power and steam may show an almost perfect balance, but if the demands do not coincide, a goodly portion of the time, generation of by-product power from the process and heating steam is not economical.

Generation of power presupposes the use of process steam and as an illustration of a typical industrial plant, a packer or a textile, operating 8 hr. a day and using 250 kw. of power and approximately 7500 lb. per hr. of steam is considered. This may well be low-pressure steam, for with the exception of enameling, drying, boiling or heating can be done equally as well as with high pressure steam, although, in existing installations, it may involve minor changes in piping and heat transfer surface.

Higher Pressure Costs Little More

When process steam is required, 100 to 150 lb. boilers are usually installed and it may safely be assumed that 250 to 300 lb. boilers, useful for by-product power generation, will cost so little more that this factor of plant cost may be discounted. There are many types of boilers to select from and my selection for this particular case would be two 250-hp. boilers with furnace volumes of not less than 1000 cu. ft. for coal or gas or 500 cu. ft. for oil. Generation of power would, however, necessitate the installation of turbine generators or engines, either of which are practical and economical. There would also be the necessary instruments and auxiliaries, without which no plant can be operated efficiently.

Looking first at purchased power, this costs not less than 2 cents per kilowatt, including the demand charge, or about $5.00 an hr. for the 250 kw. load assumed. The 7500 lb. steam per hr. can be produced at an operating cost of approximately 20 cents per 1000 lb. or $1.50 per hr. If the engineer and fireman receive $1.50 per hr. between them, the total steam plant cost would be $3.00 per hr. Inasmuch as 30 lb. per hr. is a practical water rate, the 7500 lb. per hr. steam might well be used to produce the necessary 250 kw. as a by-product without additional operating charges. This would leave $2.00 per hr. left over to pay equipment charges. These rough estimates may be criticized but they are approximately correct, although the exact figures will of course depend upon the type of plant under consideration.

Inasmuch as it does not always pay to generate power, it is necessary for the engineer to look into the question thoroughly and if he feels that there is a possible saving, estimates should be made up and presented to the company executives with the suggestion that they engage a consulting engineer to make a thorough and complete survey.

The Olson Rug. Co. plant described on page 708 of the December 1936 issue was designed after a careful study of data on the steam and electric loads and needs for future expansion. Generating facilities consist of three non-condensing bleeder type units with a total rating of 3500 kv-a. At present bleeder lines are blanked off and the entire steam supply to these units is exhausted to the process lines. Makeup steam in excess of the supply is provided from the live steam by means of a reducing valve and desuperheater station, while excess steam from the exhaust system is condensed in three large hot water storage tanks connected in parallel. After a careful study of load conditions, 300 lb., 650 deg. F. was selected as the most economical steam condition and tests made operating at 0 to 10 lb. back pressure show the average water rate of the unit to be about 25.4 lb. per kw. hr.

Steam Jet Refrigeration

In the future it is hoped that the entire plant may be air conditioned by steam jet refrigeration, operating in conjunction with a new 1000 gal. per hr. deep well. Provisions have been formulated and arranged so that the next step will probably be an 850 lb. steam generator operating at 750 deg. F. temperature with complete water walls and fired by overfeed spreader type stokers. Turbine driven draft fans will be used and when power demands exceed the steam requirements a new 1000-kw. high pressure turbine will exhaust into a 250-lb. header supplying the present turbogenerators.

Edmund E. Higginson, mechanical engineer of the Olson Rug Co., is one of the better known industrial engineers in the Chicago District and an active member of the A.S.M.E. Born in Belfast, Ireland, he served his apprenticeship there and attended the Municipal Technical College. Since coming to the United States in 1911, he studied engineering at Pennsylvania State College and has had a wide experience in industrial engineering work. He is eminently fitted by both training and experience to discuss this important subject.

In addition to designing and constructing some of the special machinery of the Olson Rug Co., he was able to interest the president of this enterprising company in constructing a new power plant during the depression. The plant has been completed and the many original features incorporated in the design reflect Mr. Higginson's personality.

Cost data on generation and performance of high and moderate pressure industrial power plants is practically non-existent. Mr. Higginson will soon have an article on this and we hope that his article will be a forerunner of similar material from other plants in all sections of the country.

Engineers of the A.S.H.&V.E. told that degree-days above 65 deg. F. is just as appliable to air conditioning as degree-days below 65 deg. F. is to heating and that it gives an acceptable basis for power estimates

POWER for Air Conditioning

By Anson D. Marston
Air Conditioning Division
Kansas City Power & Light Co.
Kansas City, Mo.

WHENEVER the installation of air conditioning equipment is under consideration, a question that always arises is "How much will it cost to operate?" This is a logical question and one for which the profession should have a reasonable answer. There is evidence that the degree-days above 65 deg. F. furnishes an acceptable basis for such estimates. This is comparable with the degree-days as used in the heating industry with satisfactory results for several years and with benefit to everyone concerned.

Theoretically it would seem improbable that the relationship between commonly furnished weather data and energy consumption would be close enough to be of value. Calculations necessary to determine the cooling load must take into consideration a number of items which are not included in heating problems and which are largely independent of weather conditions. Frequently the removal of heat and moisture due to the presence of human beings and heat from special equipment such as lights and appliances is a major part of the cooling load. Obviously this must be done regardless of the weather. Sun effect is another important item whose magnitude is largely independent of temperature and humidity readings. A study of actual data therefore discloses some surprising results.

During the period from 1934 to 1936 inclusive, a total of 72 customers operated under a special air-conditioning rate offered by the Kansas City Power & Light Co. Many of these furnished records for only a part of this period but Fig. 1 shows the relation existing between average monthly temperatures and average energy consumption for all classes of these customers. A study of this chart will show the consumption is substantially proportional to the difference between 65 deg. F. and average monthly temperature. A more detailed study of the data showed that customers whose load was primarily determined by weather conditions, residences for example, have base temperatures above 65 deg. F. while customers having a larger proportion of their load independent of weather conditions generally have base temperatures below 65 deg. F.

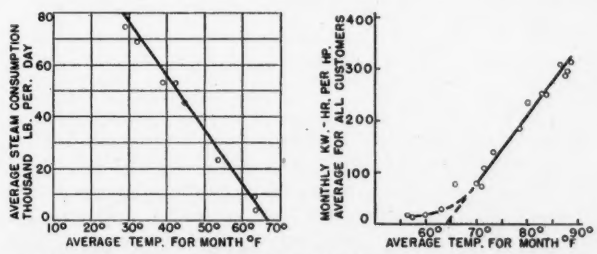


Fig. 1. Base temperature determination for degree day calculations. Left, typical heating installation. Right, power consumption for summer cooling considering all classes of customers

Table I. Energy consumption for air conditioning in Kansas City, Mo. and the division of the heating system between different months of the year.

Month	Normal Deg. Days Above 65 F.	Normal Kw-hr. Per Hp.	Normal Per Cent of Annual Total
May	104	51	7.4
June	291	137	19.9
July	436	201	29.2
August	388	180	26.1
September	201	97	14.1
October	45	23	3.3
Totals	1465	689	100.0

The important factor of relative humidity has been neglected entirely in the above investigations. Before proceeding with the use of 65 deg. F. as a base, it was considered necessary to investigate the effect of relative humidity.

Data on residential customers only cannot be considered as conclusive evidence however, because of limited data and the fact that many of these customers take extended summer vacations during which time no cooling is used. Where commercial customers only are considered, values for degree-days above 65

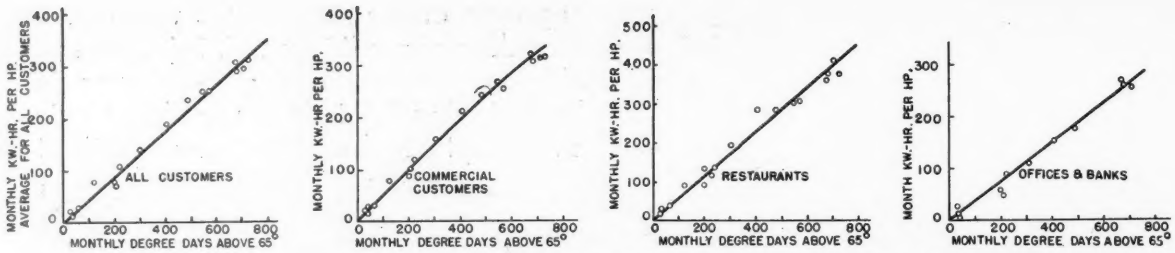

MONTHLY KW.-HR. PER HP. AVERAGE FOR ALL CUSTOMERS
ALL CUSTOMERS
MONTHLY DEGREE DAYS ABOVE 65°
MONTHLY KW-HR PER HP.
COMMERCIAL CUSTOMERS
MONTHLY DEGREE DAYS ABOVE 65°
MONTHLY KW-HR. PER HP.
RESTAURANTS
MONTHLY DEGREE DAYS ABOVE 65°
MONTH KW-HR. PER HP.
OFFICES & BANKS
MONTHLY DEGREE DAYS ABOVE 65°

Fig. 2. Energy consumption vs. degree days for different classes of air conditioning customers in Kansas City

deg. F. can be used with assurance. A separate study indicated the absence of any well defined relation between humidity and energy consumption.

From Fig. 2 and weather records it is possible to determine the normal energy consumption to be expected each month from a sizable group of air conditioning customers. This information is tabulated in Table I which indicates that a total of 589 kw-hr. per hp. can be expected in Kansas City. The distribution of this consumption among the summer months is shown by the last column of the table.

Although this information is of value when estimating the revenues to be expected from a large and representative group of air conditioning customers, it does not give the answer to an engineer desiring to tell one particular customer what his operating cost will be.

An effort was made to arrive at values which would take into account the cost based on the hours of operation. This was done by taking the 1936 customers operating a given number of hours a month, calculating the power consumption and showing it as one point. This was continued with other hours of

Table II. Consumption of energy as a function of the hours of operation per month based on a normal year in Kansas City, Mo.

Hours Open Per Month	Kw-hr. Per Hp. Per Year	Hours Actual Operation Per Year (1 Hp. = 0.9 Kw.)
720	1200	1332
660	1120	1120
600	1050	1165
540	975	1083
480	895	
420	820	911
360	745	828
300	670	744
240	590	656
200	540	600

operation until the curve was completed. A similar curve was drawn for 1935. These two curves were then adjusted to a normal year in accordance with variations from the normal degree-days about 65 deg. F. Table II shows a number of points taken from this curve and from which it it possible to estimate with reasonable accuracy the total annual consumption which any given commercial customer should experience in a normal year.

As an example, assume that the proprietor of a restaurant operating 300 hr. per month desires to know the approximate energy consumption of a 20 hp. installation which will be used during summer months only. From Table II it is noted that the total energy consumption should be 20 hp. times 670 kw-hr. or 13,400 kw-hr. By referring to Table I, it is noted that this should be distributed through the year as shown by Table III.

Mention should be made again of the fact that these data cover the operation of equipment used only for summer cooling and are applicable only to the Kansas City district. No attempt was made to include the operation of fans which are used for year-round air conditioning, although a number of fans used only in the summer months are included. Several of the installations studied have evaporative condensers or cooling towers connected on the same meter as the compressor. When this is done, it appears that the energy consumption per horsepower for such equipment was substantially the same as that for the balance of the load.

Table III. Distribution of total power consumption of a 20 hp. restaurant operating 300 hr. per mo.

May	7.4 per cent X 13,400	990 kw-hr.
June	19.9 per cent X 13,400	2665 kw-hr.
July	29.2 per ent X 13,400	3915 kw-hr.
August	26.1 per cent X 13,400	3500 kw-hr.
September	14.1 per cent X 13,400	1800 kw-hr.
Otober	3.3 per cent X 13,400	440 kw-hr.
Total		13,400 kw-hr.

Air Conditioning

UNDERSTANDING of what constitutes air conditioning is, in many cases, quite erroneous, due to the loose use of the term by contractors and some manufacturers. It is defined by the Air Conditioning Manufacturers' Association as; the scientific preparation and control of air within a structure with reference to temperature, humidity and motion. Any system or equipment which does not do this satisfactorily should not, as stated by National Better Business Bureau, be termed air conditioning.

To be sure, a fan, a pan of water or a radiator affect motion, humidity or heating, but any one alone will not produce air conditioning, nor will all three combined unless properly arranged and proportioned. For summer a system should cool, dehumidify and circulate air to give complete conditioning. For winter it should warm, humidify and circulate. Preferably there should be cleansing of the air at all times to remove dust and odors and to keep carbon dioxide down to a healthful content. These functions should be so performed as to meet minimum specified requirements.

While any one piece of equipment may improve air conditions and may properly be advocated for its particular purpose, that is not air conditioning nor is the equipment an air conditioner. Clear understanding of what constitutes air conditioning and proper use of the term by engineers will assist to give the public correct ideas and to place the whole matter of air conditioning on a sound and satisfactory basis.

Noel & Co. Nashville, Tenn., modernize plant and cut costs over $20,000 annually

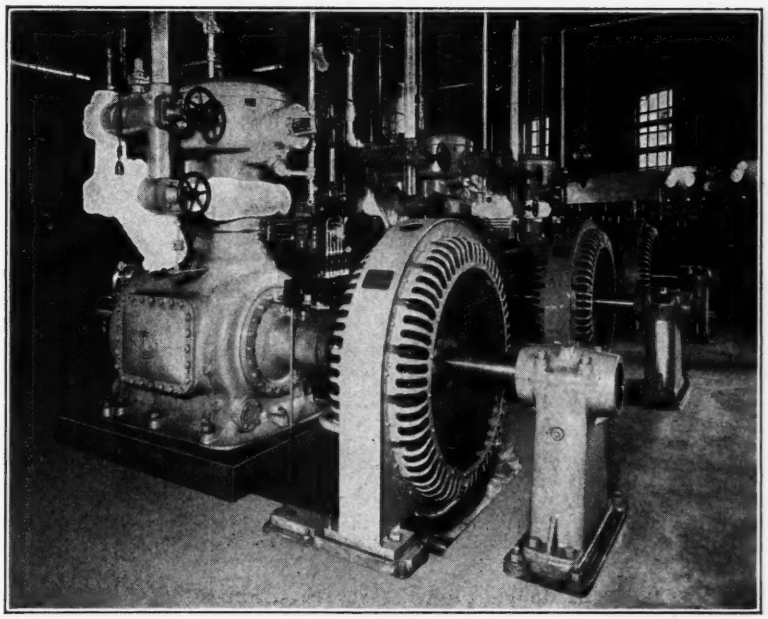


Fig. 1. These three 12 by 12-in. machines driven by 175-hp., 300 r.p.m. motors replace the old steam driven horizontal compressors

BOOSTER MACHINES Cut Refrigeration Cost

FOR SOME 25 YR., Noel & Co. have been in business in Nashville, Tenn., and now operate one of the largest cold storage plants in that section of the country, approximately 2,500,000 cu. ft. of refrigerated space, of which about 600,000 cu. ft. is freezer storage. They also manufacture 110 t. of ice per day. From the middle of February to the middle of June they break and freeze annually from two to five million pounds of eggs. At certain times of the year they receive these eggs at the rate of 1000 cases per day and hold some 32,000 dozen in storage.

Recently the load was increased by the completion of a modern three story brick and concrete building now leased to a cheese manufacturing concern. A good sized cold storage room for holding cheese in this building will be cooled with a Buffalo fan unit, taking brine from the system in the main cold storage plant.

Previous to the modernization work, the plant was operated entirely by steam with the operating cost as shown by the accompanying table. A survey indicated that electrifying the entire plant could, by conservative figuring, amortize the total investment within a 5-yr. period. The engineering work was done by the Atlanta branch office of the Frick Company and the contract for the installation work was given to the Radabaugh-Corbitt Co. of Nashville. Annual power requirements for the remodeled plant were estimated at about three million kilowatt hours, representing a savings of about $20,000 annually. Preliminary operation indicates that the actual operation will be even better than this.

In the old plant the entire load, including both storages and ice-making, was carried at the low suction pressure of 12 lb. By installing boosters to carry the cold storage load it was possible to carry the ice plant load separately on 20-lb. suction. Still further saving would have been obtained by carrying the freezer load separate from the comparatively high temperature cold storage load but this was not practical because of the arrangement of the piping.

Annual Operating Cost of the Old Steam Driven Plant of Noel and Company, Nashville, Tenn.

Coal	$26,749
Boiler and engine room labor	18,163
Repairs and maintenance of boiler and engine room	7,000
Oil, packing, waste boiler compound, etc.	3,127
Water bill	2,629
Ammonia costs	4,370
Calcium costs	1,018

Suction Lowered

Old steam driven, horizontal compressors were replaced by three 12 by 12-in. Frick machines, each driven at 300 r.p.m. by a 175-hp. motor. Two 11½ by 8-in. Frick boosters, each driven by a 40-hp. motor, were also installed. Four new 42-in. diameter by 14 ft. high Frick standard vertical shell and tube condensers now do the work formerly requiring 43 stands

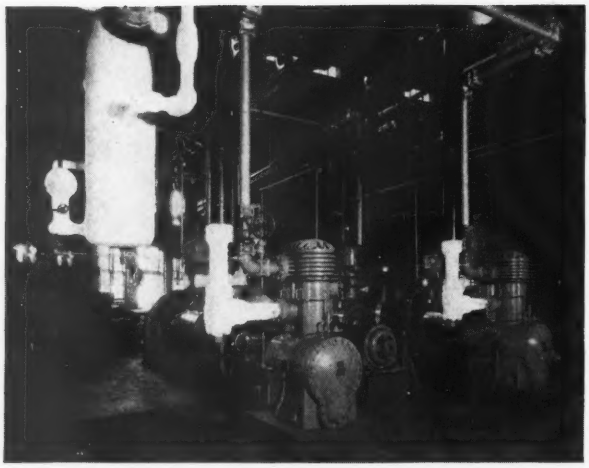


Fig. 2. Two 11½ by 8-in. boosters, driven by 40-hp. motors, are installed. The three 12 by 12-in. machines appearing in Fig. 1 are located in the background behind the booster compressors.

of 1¼ in. and 2 in. double pipe condensers, 12 pipes high and 18 ft. long, and 10 stands of 2 in. atmospheric condensers.

Although the old ice tanks were used, they were raised 6 in. in height and supplied with new verti-flow coils with accumulators, vertical agitators, frame work, supports and covers, new dumps and can fillers and a complete F-P air system. Each of the two large tanks have 696 cans of 300-lb. size.

Power Savings

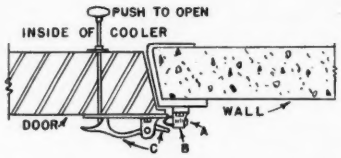
Power savings of the new arrangement were estimated on the basis of 110 t. of ice daily plus 7.5 per cent overage. Assuming 85 deg. water entering the cans, this would mean a little more than 200 t. of refrigeration. This load, carried at 12.2 lb. suction pressure, would require some 360 br. hp. for driving the compressors. Raising the suction to 20 lb. gives a clear saving of 56.5 br. hp. Carrying the low temperature part of the load at approximately 0 lb. suction pressure with a booster compressor, gives a further saving of 27.5 br. hp. over that required by a single stage system.

Fig. 3. The old ice tanks were modernized by raising 6 in. and installing modern equipment. Each of two large tanks have 696 cans.

Refrigeration Safety

FAILURE of a cooler door lock which might well have resulted in a fatal accident was described in a recent issue of the National Safety Council News Letter by H. M. Toombs of Armour & Co., Chicago, Ill. The lock in question, shown in the accompanying illustration, is in common use. The door is opened from the inside of the cooler by pushing the handle straight forward so as to unclasp the latch.

In this particular case the pin, A, dropped out, allowing the spring to force the latch to the left so that the end passed through the square hole in the casting, B, and dropped out of alinement so that it could not be moved by pressure from lever C from the inside of the door in fact the casting had to be smashed



Failure of this door fastener imprisoned a man in the cooler for several hours. A light signal operated from the inside of the cooler has been installed.

before the door could be opened even from the outside. The accident occurred after everyone had left the department and consequently a man was imprisoned in the cooler several hours at a temperature below zero. To safeguard against such an accident in the future, a red signal light operating from the inside of the cooler and flashing in the main engine room has been installed.

Six developments on the Feather River (Calif.) are proposed by the Pacific Gas and Electric Co. and are now awaiting the result of a hearing before the Federal Power Commission on Nov. 15.

Howells plant, 1 mi. downstream from the present Caribou plant would have a dam 145 ft. high, tunnel 25,000 ft. long, head of 650 ft. and installation of 61,000 kva. At Camp Rodgers plant, 2 mi. further down stream, a dam 105 ft. high with tunnel 18,000 ft. long would give 295 ft. head and capacity of 59,000 kva. Rock Creek development ¼ mi. below the mouth of Chambers Creek with dam 55 ft. high and 25,000 ft. tunnel would have 370 ft. head and 72,000 kva. capacity. Cresta plant, across the North Fork from the mouth of Grizzly Creek will have a dam 125 ft. high, a 17,000 ft. tunnel, head of 290 ft. and 64,000 kva. capacity. Pulga development a little upstream from Big Bar gaging station, with a 35-ft. dam and 14,000-ft. tunnel will develop 270 ft. head and 62,000 kva. Poe plant, 1½ mi. below Poe siding, will have a dam of 180 ft., a tunnel 3000 ft. long, head of 197 ft. and capacity of 50,000 kva.

All plants will be connected to the company's transmission system which at present, has 39 hydro-electric and 8 steam-electric plants, with a total of 426,608 hp. connected to it.

Why Pumps Stop

By TOM THUMB

SINCE THE beginning of steam pumps the absorbing question, among operating engineers, has been, "Why do steam pumps stop at mid stroke on a lean throttle?"

Supposedly the duplex steam pump is the nearest to being "fool proof" of any apparatus in the power plant yet at a certain age it has a tendency to "hang up" at mid stroke.

This feature does not seem to be so prominent in the simplex type of apparatus; the single cylinder pump seems to get tired at the end of the stroke.

As simplex steam pumps depend on pilot valves and auxiliary pistons to move the main valve, it is evident that undue friction will cause tardy action of the auxiliary gear; this will slow or even stop the main piston from reversing.

Some types of simplex pumps employ the auxiliary piston as pilot valve and these pumps appear to give more trouble than the first named type.

Engineers learn that a good operating simplex pump depends on lubrication for its steady and uninterrupted action. The latter type mentioned especially requires plenty of cylinder oil.

When a Corliss engine is sufficiently internally lubricated to insure good action of the releasing valve gear, the piston will be properly oiled!

This holds good also regarding a steam pump; when the valve gear is properly lubricated internally, no fear need be felt regarding the piston or pistons.

Seemingly, lubrication or lack of lubrication accounts for much of our pump troubles. If the simplex pump is stinted on internal lubrication it not only grunts and groans but it refuses to respond and stops at the end of the stroke.

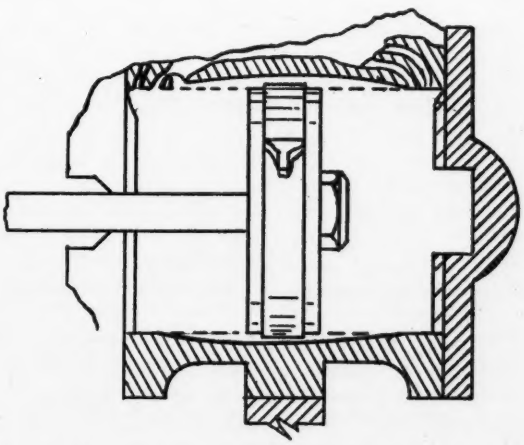


Fig. 1. Showing excessive wear at mid-stroke caused by lack of proper lubrication or very stiff piston rings. Leakage around ring causes pump to stop at this point on lean throttle

The duplex variety, being of different principle and design, though it may protest, by aforementioned noises, its displeasure at shortage of oil will continue to function.

The stroke may shorten a trifle but the machine will continue to reciprocate—up to a certain time. The length of this time will depend on the toughness of the cylinder iron and the stiffness of the piston rings.

Apparently the speed of the piston has a lot to do with the wear. At the middle of its stroke the piston is making the highest speed and likewise the greatest wear is shown. (Fig. 1.)

That is why the pistons of a duplex pump stop at half stroke on a lean throttle, the leakage is so great at this point that sufficient pressure to push the piston further is lacking.

The single concentric ring (Fig. 2) perhaps wears faster—when lubrication is lacking—than other types and this type of ring is too complicated for the novice to try to imitate.

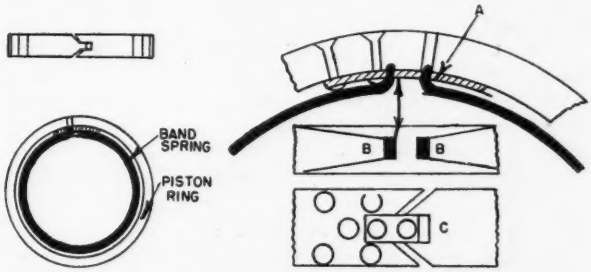


Fig. 2. Ring Joint Showing Tongue—A: Joint plate riveted to one side of joint and slotted for spring to clear at A. B: Band spring tapered at end. C: Joint showing tongue

But by careful study and a little practice the ordinary plant engineer or mechanic with a half decent lathe may turn out a mighty satisfactory and passable job of ring building.

To begin with the maximum diameter of the cylinder must be known. It may be worn a sixteenth or even three-thirty seconds of an inch. The ring must be large (in diameter) enough to also give sufficient lap to make a perfect seal.

A pattern can easily be made from which suitable ring casting stock can be molded.

It is well to allow a full eighth of an inch outside and the same amount of the core so that a slight misadjustment in chucking will not spoil the job. This will have to be determined by the one doing the work.

The lap on the ring will be 3.1416 times the diameter allowed above the actual size. For example: If new rings were being made for a cylinder exactly six inches in diameter and a lap of five-sixteenths of an inch was desired, the diameter of the ring would be

$$6 + \frac{0.3125}{3.1416} \text{ or } 6.0994 \text{ in.}$$

On a ring of that diameter the fat part of the ring should be one-quarter or five-sixteenths of an inch thick and the thin part one-eighth of an inch. This will allow

the ring to fill the cylinder without buckling opposite the joint.

If care is taken and the joint is made as shown in Fig. 3, two rings being placed side by side (instead of one wide ring, as shown in Fig. 2), and two rings inside of the outer rings, as near a perfect joint as possible can be made.

It must be remembered that when replacement rings are made for a cylinder that is badly worn in the center, as shown in Fig. 1, the joint will have to lap the amount desired plus the over diameter.

That is to say: If the six-inch cylinder has worn three thirty-seconds and a five-sixteenth inch lap is desired, the ring as turned will have an external diameter of 6.09375 plus 0.0994 or 6.19315.

Now it must also be remembered that the ring when at the end of the stroke (where the cylinder is not worn) will have to compress to six inches. Therefore: The openings cut to form the lap joint will have to be wide enough to allow the extra play.

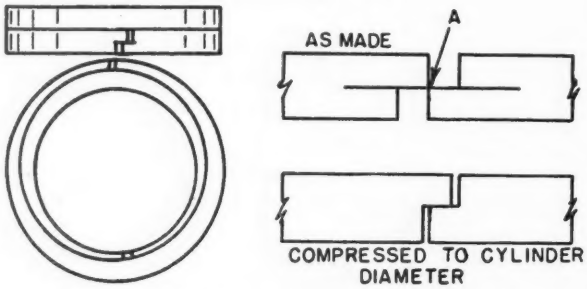


Fig. 3. Eccentric Piston Rings. Four to a set. One pair inside; one outside. Step or Lap Joint—The eccentric is marked exactly in center with scratch gauge. (upper) A fine file is now used to make cuts as shown

The question arises as to the way of setting off the ring stock after the external diameter has been obtained to get the right thickness at the fat part of the ring and also the lean or thin part.

If five-sixteenths are desired on the heavy side and three-sixteenths on the thin side, the sum of the two will be eight-sixteenths or one-half inch. Then the internal diameter will be one-half inch less than the external diameter.

The difference between the fat part (five-sixteenths) and the thin part (three-sixteenths) is two-sixteenths, or one-eighth of an inch.

After the external diameter is completed, the work must be set off center half of the difference of the two thicknesses; $\frac{(\frac{5}{16} - \frac{3}{16})}{2}$ or $\frac{1}{16}$.

The best way to set off a piece of work (this applies to the expert as well as the novice) is to know the number of threads to the inch of the chuck jaw screws. For instance if this should be sixteen—one complete turn loosened on the side opposite the tool post and the adjacent screw (to the post) tightened the same amount would give the necessary throw. We are dealing strictly with four jaw chucks.

A careful study and practice (as I have already suggested) will surprise the uninitiated at his ability to turn a decrepid old relic—through the medium of the piston rings here described—into a member in good standing of the pump fraternity.

Safe Ending Boiler Flues and Superheater Tubes

DUE TO SERVICE CONDITIONS, flues and tubes in locomotive boilers oxidize and pit rapidly. This action is most noticeable near the end of the tubes and for many years it was standard practice in railroad work to cut off the weakened end and add new pieces from 8 to 12 in. long. This is known as safe ending. Originally the new piece was expanded and the old piece swedged down and the two fitted together to form a lap which was welded with a pneumatic hammer. The rejection was high. Later this work was done by resistance welding, the two ends being machined accurately so as to obtain a perfect contact with the ends before the weld was made.

With the advent of better welders, machining is no longer necessary. Modern practice is to tumble or rattle the tubes for a number of hours in a revolving drum with a solution of hot water and steam, occasionally with chemicals added, to remove rust and scale. Damaged ends are then cut off in a pipe mill or pipe cutter after which they may be touched up slightly on a sand paper belt machine. Both ends are then clamped in the welder and the weld made in a period of a few seconds by the flash process. The mechanical pressure applied makes a slight upset or swelling in the vicinity of the weld. The flue is immediately unclamped, shoved quickly over the mandrel around which three rollers are revolving. These roll down the upset leaving a smooth surface on the inside and outside diameters.

Latest method of preparing tubes for safe-ending for welding. Left shows the tube cut off in a paper mill, right the end cut off by a disk cutter. Lathe work, found advisable or necessary until a few years ago, has been discontinued as unnecessary. After welding they are rolled on a mandrel to give a smooth inside and outside surface

The welds were formerly tested by air or steam pressure but this practice has been found largely unnecessary and the tubes are now largely installed in the boilers without testing. Flues may be safe ended this way 10 or 12 times and shorter pieces of tube are often welded together to form a larger tube, a process known as reclaiming or salvaging.

Present practice was described quite thoroughly by H. A. Woofter in a recent issue of The Welding Journal. Typical costs range from $0.0104 dollars for electric safe ending of 2-in. flues to $0.0492 for 5 3/8 in. tubes.

The same type of machine is sometimes used in a manufacturing plant to weld together sections of standard pipe to give lengths of up to a half mile. In one process described 2-in. diameter standard pipe was made up into heating coils by welding in this way and winding around a form to make coils 10 ft. in diameter for heat exchanger work.

BOILER PATCHES

Although the text of the A. S. M. E. Boiler Code is rather non-committal on patches, beyond stating that they must comply with regular material and workmanship standards, it does say "No welding or patching shall be done except upon and in acordance with the advice of an authorized boiler inspector."

This throws a great deal of responsibility upon the inspector and has resulted in the compilation of detailed rules and procedure for the guidance of these men when recommendations must be made.

These rules are discussed by the author, from a background of many years practical experience and from the standpoint of an inspector for one of the larger insurance companies.

By C. C. CUSTER

WITH THE EXCEPTION of locomotive firebox type boilers, which on the road with forced draft and extremely hard service require frequent repair, patches are most prevalent on the horizontal return tubular, or commonly called h.r.t., boiler. The most vulnerable parts of this boiler are the fire sheets which from the vicissitudes of poor management and careless operation may be bagged by scale, mud or oil deposits. Frequently fire cracks or other signs of distress caused by overheating, appear at the girth seam or, at the rear head where tube ends become burned and leaky through excessive deposits of scale. Patches on the drums of water tube boilers are infrequent as the drums are not subject to the hottest flame passes and the tubes generally take the punishment.

Practical problems of patching require close preliminary study. If the bag is not down too far it may be possible to heat the sheet and drive the bag back without spoiling the contour of the shell. If, however, the bag is too extensive this will not be feasible without leaving a wrinkle in the shell and thinning the sheet so as to make a permanent weak spot. If a patch must be added the size and shape to be used depends on the position and area of the bag.

To make calculations easy, the following rules for riveted patches have been formulated by experienced organizations and cover the matter of designing the patches in considerable detail. Unfortunately, patches are often designed and put on by boiler makers who are not sufficiently well acquainted with the mathematics of the problem to shape the patch properly so as to conserve the safe working pressure of the boiler at the maximum value.

Often a boiler inspector comes along and finds a patch already in place, designed and shaped so that the laws of the state require a reduction of the working pressure of the boiler. If the owner wishes to maintain the full working pressure, such a patch must be replaced by one of proper design.

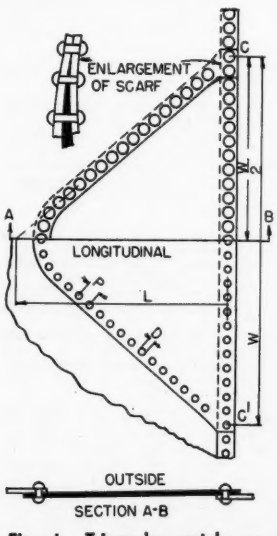


Fig. 1. Triangular patch on a girth seam at the bottom of a boiler. The patch is on the inside but this and the other drawings are made as an outside view just as you would see it while lying on your back in the furnace, looking upward. P is the rivet pitch and D the diameter of the hole

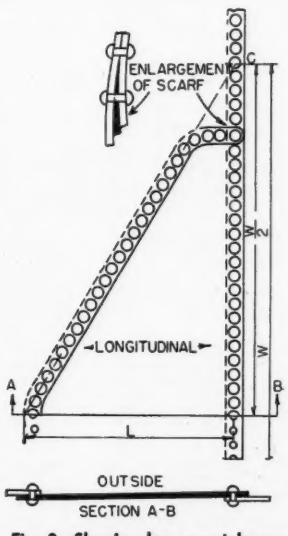


Fig. 2. Showing how a patch may be shortened girthwise up to the point where no more than four rivets are in a line parallel with the longitudinal seam. The length L of the patch is always measured parallel with the longitudinal seam of the boiler. The width W is always greater than L making the ratio of W to L greater than unity

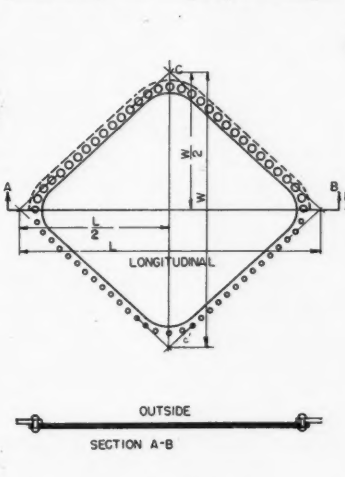


Fig. 3. Diamond shape patch placed inside and at, or, near, the center of the sheet. Note that this patch involves no longitudinal seam and theoretically E equals 100. Using 95 from Tables II or III gives a factor of safety

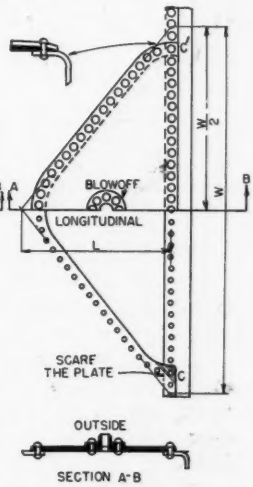


Fig. 4. Triangular patch at the head seam and blowoff on bottom of boiler. These patches are put on the outside while the others shown by Figs. 1, 2, 3, 5 and 6 are all on the inside

In the past local and state laws have differed somewhat in regard to patches. One state code allowed a circular single riveted patch to be used up to 8 in. in diameter; another state up to 12 in. while several states set the limit of a patch 24 in. long and required a new fire sheet to be installed if the patch necessary exceeded this dimension.

When considering patches it is well to remember that the length, as referred to patches, is taken to mean the dimension of the patch in the direction of the length of the boiler or longitudinal seam, irrespective of whether this may be the long or short diameter or axis of the patch itself.

Since various state codes have been more or less

RULES FOR RIVETED PATCHES

A patch should be laid out in the flat and then carefully formed to accurately fit the contour of the boiler where it is to be applied.

Patch plates should be of the same thickness as the original thickness of the plate they replace.

Seams exposed to the products of combustion should be single riveted lap construction.

Seams not exposed to the products of combustion should be double riveted or constructed similar to the original seams of the boiler.

Patches exceeding 24 in. in length should have the proper width as determined by the section on calculations.

Patches less than this in length should be triangular, crescent, diamond or oval in form and the width should be at least twice the length.

If it is found that a patch would extend extremely high, or, to avoid the necessity of calking in sharp corners, a patch may be shortened in width to the extent that no more than four rivets will be in a longitudinal line, as shown in Fig. 2.

If it is found that a patch would have to be 60 in. or more in length consideration should be given to the use of a sheet having a width equivalent to ⅝ of the circumference of the boiler and with the longitudinal seam of a design similar to the original seam of the boiler.

In designing patches, it is not necessary to deal with angles in terms of degrees, but merely with the dimensions of the triangles forming a patch. The relation between the length and width provides certain fixed constants that have been tabulated and designated as Tables II and III. The constant "C" is the figure by which the length should be multiplied to determine the width.

If a patch is diamond in shape, it is considered equivalent to two triangular patches and half the total length is used in determining the width.

The first thing that should be taken into consideration when proceeding with the design of a patch is whether all of the end stress is to be carried by the patch; in other words, whether the heads are supported or unsupported. In drums of water tube boilers, the full end-wise stress has to be carried by the shell plates and the patch seams, whereas, in shells of horizontal tubular boilers some of the end-wise stress is carried by the through rods, tubes or flues so that there is less stress on the shell and patch seams. It is evident then that in the one case a patch need not have the same width for a given length as in the other case. Different constants may be used in determining the width and the two tables, II and III, have been prepared taking into account these different conditions.

As the angle of a patch as laid out when flat does not change when formed to the curvature of the boiler, the diameter of the boiler does not have to be taken into consideration in the design.

In laying out new patches over 24 in. long, it is recommended that they be triangular or diamond in shape, as may be required for the particular job, with definite straight line sides but with the corners properly rounded out to permit proper calking, as illustrated in Figs. 1, 2, 3 and 4. Proper points for measuring the length "L" and the width "W" are also shown by these figures.

Rivets, patch bolts or staybolts may be used in "riveted" seams surfaces that are stayed or braced, provided at least one rivet or patch bolt is used between adjacent staybolts. The riveting should be completed first.

On shells that have braced heads, rivet holes may be countersunk in patches if desired, without materially affecting the calculated strength of the patch. The angle of the chamfer with center line of the rivet hole should not exceed 45 deg. and the depth should not exceed half the thickness of the plate.

Where patches have already been applied the problem is to determine the effective diagonal efficiency. If the seams are all rounded, that is to say, the patch is crescent or oval in shape, the length "L" should be taken between the center of the extreme two rivets on the longitudinal center line and the width "W" between the center of the extreme two rivets on the girthwise center line, as illustrated in Figs. 5 and 6.

E—EFFICIENCY OF LONGITUDINAL SEAMS OR DIAGONAL EFFICIENCY IN PER CENT	e—EFFICIENCY OF PATCH SEAMS IN PER CENT															
		50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
	65	1.68	1.60	1.51	1.43	1.36	1.28	1.20	1.13								
	66	1.75	1.67	1.58	1.50	1.42	1.35	1.27	1.19								
	67	1.82	1.73	1.65	1.57	1.49	1.41	1.33	1.26	1.18							
	68	1.88	1.79	1.70	1.63	1.55	1.47	1.40	1.32	1.24	1.16						
	69	1.94	1.86	1.77	1.69	1.61	1.53	1.45	1.38	1.30	1.23	1.15					
	70	2.01	1.91	1.83	1.75	1.67	1.59	1.52	1.44	1.36	1.30	1.22	1.15				
	71	2.06	1.97	1.89	1.81	1.73	1.65	1.57	1.50	1.43	1.35	1.28	1.21	1.15			
	72	2.12	2.03	1.95	1.86	1.79	1.71	1.63	1.56	1.48	1.41	1.34	1.27	1.20	1.14		
	73	2.17	2.09	2.00	1.93	1.85	1.77	1.69	1.62	1.54	1.47	1.40	1.33	1.26	1.19	1.13	
	74	2.22	2.14	2.06	1.98	1.91	1.83	1.75	1.67	1.60	1.52	1.45	1.39	1.32	1.25	1.18	
	75	2.28	2.20	2.12	2.04	1.96	1.88	1.81	1.73	1.66	1.58	1.51	1.44	1.37	1.31	1.24	1.17
	76	2.34	2.25	2.17	2.09	2.02	1.93	1.86	1.79	1.71	1.64	1.57	1.50	1.43	1.36	1.30	1.23
	77	2.39	2.31	2.22	2.15	2.07	2.00	1.92	1.84	1.76	1.69	1.62	1.55	1.48	1.42	1.35	1.29
	78	2.44	2.36	2.28	2.20	2.13	2.05	1.97	1.89	1.82	1.75	1.67	1.61	1.54	1.47	1.41	1.35
	79	2.50	2.42	2.33	2.25	2.18	2.10	2.03	1.95	1.87	1.81	1.73	1.66	1.59	1.52	1.46	1.40
	80	2.55	2.46	2.39	2.30	2.23	2.15	2.08	2.00	1.93	1.86	1.79	1.72	1.64	1.58	1.48	1.45
	81	2.60	2.51	2.43	2.36	2.28	2.20	2.13	2.05	1.98	1.91	1.84	1.77	1.69	1.63	1.57	1.50
	82	2.65	2.56	2.48	2.40	2.33	2.25	2.18	2.11	2.03	1.97	1.89	1.82	1.75	1.68	1.62	1.55
	83	2.70	2.62	2.53	2.45	2.38	2.30	2.22	2.15	2.08	2.01	1.94	1.87	1.80	1.73	1.67	1.60
	84	2.75	2.66	2.59	2.51	2.43	2.35	2.27	2.20	2.13	2.06	1.99	1.92	1.85	1.78	1.72	1.65
	85	2.80	2.71	2.63	2.56	2.48	2.40	2.32	2.25	2.18	2.11	2.04	1.97	1.90	1.84	1.77	1.70
	86	2.85	2.77	2.68	2.60	2.52	2.45	2.37	2.30	2.23	2.16	2.09	2.02	1.95	1.89	1.82	1.75
	87	2.90	2.82	2.74	2.65	2.57	2.49	2.42	2.34	2.28	2.21	2.14	2.07	2.00	1.93	1.87	1.81
	88	2.96	2.87	2.78	2.71	2.62	2.54	2.47	2.40	2.33	2.25	2.19	2.12	2.05	1.98	1.92	1.85
	89	3.01	2.92	2.83	2.75	2.66	2.59	2.52	2.44	2.37	2.30	2.23	2.16	2.10	2.03	1.96	1.90
	90		2.97	2.89	2.80	2.71	2.65	2.57	2.50	2.42	2.34	2.27	2.21	2.14	2.08	2.01	1.95
	91			2.94	2.86	2.77	2.69	2.62	2.54	2.47	2.39	2.32	2.25	2.19	2.12	2.06	2.00
	92			2.99	2.90	2.82	2.74	2.66	2.59	2.51	2.44	2.36	2.30	2.23	2.17	2.10	2.04
	93				2.95	2.87	2.78	2.70	2.63	2.56	2.48	2.42	2.34	2.28	2.21	2.15	2.08
	94					2.91	2.83	2.75	2.67	2.60	2.53	2.45	2.39	2.32	2.25	2.19	2.13
	95						2.87	2.79	2.72	2.64	2.57	2.50	2.43	2.36	2.29	2.23	2.17

Table II. Table of Constants C for crescent, triangle, diamond or oval patches for supported heads as in h.r.t. boilers where the girth seam carries only part of the load

Regardless of the axis of the patch, the length L is always taken as the dimension parallel with the longitudinal seam and the width "W" as the dimension parallel with the girth seam. In the case of crescent and triangular patches $C = W \div L$ or transposed, $W = C \times L$ and $L = W \div C$. Due to the nature of the problem and the design of the shell the stress on the longitudinal seam is twice that on the girth seam.

When C is equal to 1, that is when W equals L, the patch seam is at a 45 deg. angle with both the longitudinal and girth seams and these two components of the patch seam stress are equal, that is the seam is weak longitudinally. As C is increased by making W larger the angle flattens out and the longitudinal stress component becomes smaller. Thus C taken from these tables and used in the calculations takes account of the angle of the patch seam without actually determining the angle in degrees. In practice, W will always be greater than L so that C is always greater than unity.

It will be noted, from Figs. 1 and 3 and 5 and 6, that diamond and oval patches are made up of two triangular and two crescent patches respectively placed back to back. Inasmuch as the limiting factor is the strength of the seams and not the full metal between the two halves, the calculations must be the same for the two types. To prevent confusion it seems desirable to avoid the use of two symbols for the length of the patch. When calculating diamond and oval patches it is important to remember that the effective length is but one half the true length. For oval and diamond patches the formulas in the second paragraph ahead may be used as $C = 2W \div L$, $W = C \times L \div 2$ and $L = 2W \div C$.

This constant C is obviously the tangent of the angle made by the patch seam with the longtinudinal seam. For angles of about 63½ deg., (when the tangent equals 2), the patch is as strong longitudinally as it is girthwise, at smaller angles it is weak longitudinally, at greater angles weak girthwise. Tables II and III take account of this angle as well as the efficiencies of the joints.

Table I. Single riveted seam efficiency for a tensile strength (TS) of 55,000 and a rivet shear stress (SS) of 44,000 lb. per sq. in.

PLATE THICKNESS	RIVET HOLE DIAMETER	PITCH OF RIVETS	EFF. OF SEAM
t in inches	d in inches	p in inches	e in %
1/4	11/16	1 7/8	63.3
9/32	3/4	1 7/8	60.
5/16	3/4	1 7/8	60.
11/32	13/16	1 15/16	58.
3/8	13/16	1 15/16	57.
13/32	7/8	2 1/16	57.5
7/16	15/16	2 1/4	56
15/32	15/16	2 1/8	55.5
1/2	1	2 1/4	52.5
9/16	1 1/16	2 3/8	53.
19/32	1 1/16	2 1/4	52.8
5/8	1 1/16	2 1/4	50.5
21/32	1 1/8	2 5/16	51.4
11/16	1 1/8	2 5/16	51.4

Length "L" of the patch should first be determined as this is governed by the area of the defect. The normal efficiency "e" of the single riveted seam that is to be used in the patch should next be determined from Table I. This is governed by the thickness of plate and diameter of rivet holes.

After determining the length the patch must be, the next step is to determine what the girthwise width should be. This is found by multiplying the length by the constant "C" from Table II or III, depending upon the type of boiler to be repaired. These tables give the constant "C" for a given efficiency "e" of the patch and efficiency "E" of longitudinal seam and the proper method of use is shown by Problem 1.

To determine the longitudinal efficiency of an existing patch, "L" and "W" should be measured, and the pitch "p" and diameter of rivet "d" determined. For crescent or triangular patches "W" divided by "L" will give the constant "C" and Table I will give the single riveted seam efficiency "e". Then under the proper value of "e" (depending upon the type of boiler to be repaired) and the constant "C" "E", the longitudinal or allowed efficiency of the patch seam, is found at the left hand column of Table II or III, depending upon the type of boiler being repaired. The proper procedure is illustrated by Problem 2.

MATERIAL

Patch material shall be of firebox or flange steel depending upon the plate it replaces. Tank steel must not be used and the repair shop should be required to produce a copy of the manufacturer's test report of the material to be used.

The material shall contain the steel maker's brand. If only part of a plate is required and this part does not contain the brand, the brand should be transferred to the patch plate in the presence of a commissioned boiler inspector or a representative of the plate manufacturer before the plate is cut.

Rivets, patch bolts or staybolts shall be of material of standard quality.

In cases where exposed to the products of combustion and where deposits would be pocketed, all patches must be placed inside the boiler. An exception is where a blow-off is attached and in this case the patch should be placed on the outside as shown by Fig. 4.

All defective material exposed to the products of combustion should be removed and properly trimmed to provide for neat workmanship in attaching the patch. Defects not exposed to the products of combustion need not be removed unless necessary to make a good job.

So that the patch may be made as small as possible, a distorted sheet which is to be patched should first be set back as straight as possible before proceeding with the cutting out of the plate.

The edge of a patch should be beveled by planing, chipping or gas cutting before applying it to the boiler and rivets should be driven by gun if at all possible.

All rivet holes should be drilled full size, or, the holes may be punched not to exceed ¼ in. less than full size for plates over ⅝ in and ⅜ in. less for plates ⅝ in. or less in thickness and then reamed to full size with the patch in place. Rivet holes are usually 1/16 in. greater in diameted than the normal diameter of the rivet but ⅛ in. difference is preferable when the rivets are of uniform size.

If seal welding is used it should be laid in a single bead with a throat thickness not less than 5/16 nor more than 5/16 in. The patch should be tight under a hydrostatic test equal to the operating pressure before seal welding.

Where three plates have to be lapped at the corners of a patch, the middle plate

Table III. Table of Constant C for water tube boilers or shells which are not stayed so that the girth seams take all the end thrust or load due to internal pressure.

E—EFFICIENCY OF LONGITUDINAL SEAMS OR DIAGONAL EFFICIENCY IN PER CENT	e—EFFICIENCY OF PATCH SEAMS IN PER CENT															
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
65	2.80	2.06	1.93	1.80	1.69	1.56	1.45	1.35	1.24	1.14						
66	2.30	2.16	2.03	1.90	1.78	1.66	1.55	1.45	1.34	1.22	1.12					
67	2.40	2.26	2.13	2.00	1.88	1.75	1.64	1.52	1.43	1.32	1.21					
68	2.50	2.36	2.23	2.10	1.98	1.86	1.73	1.63	1.52	1.42	1.31	1.19				
69	2.62	2.46	2.33	2.20	2.07	1.95	1.84	1.71	1.61	1.50	1.40	1.30	1.17			
70	2.75	2.57	2.43	2.30	2.16	2.04	1.93	1.80	1.69	1.59	1.49	1.37	1.28	1.16		
71	2.87	2.70	2.53	2.40	2.26	2.14	2.02	1.90	1.79	1.67	1.57	1.47	1.37	1.26	1.15	
72	3.00	2.81	2.65	2.48	2.36	2.23	2.11	1.99	1.88	1.76	1.66	1.56	1.45	1.36	1.26	1.14
73	3.14	2.93	2.76	2.60	2.46	2.33	2.20	2.09	1.97	1.87	1.75	1.64	1.54	1.44	1.35	1.24
74	3.28	3.07	2.87	2.71	2.56	2.42	2.30	2.19	2.06	1.95	1.83	1.73	1.62	1.52	1.43	1.34
75	3.38	3.19	3.00	2.83	2.66	2.52	2.40	2.27	2.15	2.05	1.92	1.81	1.71	1.61	1.51	1.42
76	3.52	3.32	3.14	2.96	2.78	2.62	2.49	2.36	2.24	2.12	2.01	1.90	1.79	1.69	1.60	1.50
77		3.46	3.28	3.07	2.90	2.74	2.58	2.45	2.32	2.22	2.10	1.98	1.88	1.77	1.67	1.58
78			3.40	3.19	3.03	2.85	2.59	2.55	2.42	2.30	2.19	2.07	1.96	1.86	1.75	1.66
79				3.32	3.16	2.97	2.80	2.65	2.51	2.39	2.27	2.16	2.05	2.94	1.84	1.74
80				3.46	3.28	3.10	2.98	2.75	2.61	2.48	2.36	2.24	2.14	2.03	1.93	1.83
81					3.40	3.20	3.03	2.87	2.71	2.57	2.45	2.33	2.21	2.11	2.00	1.90
82						3.34	3.16	2.97	2.82	2.67	2.53	2.42	2.30	2.19	2.09	1.98
83						3.46	3.29	3.10	2.93	2.78	2.63	2.50	2.39	2.27	2.17	2.06
84							3.39	3.22	3.05	2.87	2.75	2.59	2.47	2.37	2.25	2.15
85								3.32	3.17	2.99	2.83	2.69	2.55	2.44	2.34	2.23
86								3.45	3.29	3.13	2.96	2.78	2.65	2.54	2.42	2.32
87									3.40	3.24	3.07	2.90	2.76	2.62	2.50	2.40
88										3.32	3.17	3.00	2.86	2.71	2.59	2.47
89										3.46	3.29	3.14	2.97	2.81	2.68	2.56
90											3.40	3.24	3.07	2.93	2.78	2.65
91												3.35	3.19	3.03	2.87	2.75
92												3.45	3.29	3.14	2.97	2.83
93													3.39	3.24	3.09	2.93
94														3.32	3.19	3.03
95														3.43	3.28	3.14

should be carefully scarfed to a feather edge the entire width of the lap, as shown in the attached illustrations.

Upon completion of repairs, a hydrostatic test of 150 per cent of the operating pressure should be applied and the patch seams should be tight at this pressure.

Solution of Problems

No. 1—Design of a patch for an H.r.t. Boiler. A crescent patch is to be placed in the firesheet of a horizontal return tubular boiler having a shell plate 7/16 in. thick, longitudinal seam efficiency "E" of 74 per cent. Length of patch is to be 36 in. Find the width "W" of patch, to be applied so that there will not be a reduction in pressure, using a single riveted seam of normal design.

Referring to Table I it is found that a 7/16 in. plate with a 15/16 in. diameter rivet holes, pitch 2¾ in. gives a seam efficiency "e" of 56 per cent.

Referring to Table II, with "E" 74 per cent and "e" 56 per cent, Constant "C" is found to be 1.75.

Then width $W = L \times C = 36 \times 1.75 = 63$ in. Note this formula applies only to a triangular or crescent patch. For oval or diamond patches the formula must be modified as explained in the small type under Table II.

No. 2—Pressure allowance on an existing patch. A crescent shape patch has already been installed on a horizontal tubular boiler. It is found to be 30 in. long and 48 in. wide. The seam is a single riveted with 13/16 in. rivet holes pitched 1 15/16 in. The boiler shell plate is 5/8 in. thick. The longitudinal seam is of the double riveted butt strap type, having an efficiency of 82 per cent. The safety valve is set for 125 lb. pressure. What maximum pressure should be allowed on the boiler?

Referring to Table I the normal efficiency of the patch seam "e" is seen to be 57 per cent. If the efficiency is not found in the table refer to any other available table or determine it in the customary manner as described in Pars. A-1 and 2 of the Appendix of the A.S.M.E. Code.

Divide the width of the patch "W", 48 in., by the length "L", 30 in., to find the Constant "C". 48 divided by 30 equals 1.60.

Follow down the column "e" equals 57 of Table II to C equals 1.60. This is somewhere between 1.56 and 1.62 and "E" is somewhere between 72 and 73. As the difference between 1.56 and 1.62 is 6 and the difference between 1.56 and 1.60 is 4, "E" will be 72 plus 4/6 of 1 per cent or 72.66.

The pressure approved varies directly as the seam efficiency. Accordingly the pressure will have to be reduced in the ratio of 72.66 divided by 82 or 88.61 per cent of the former value. 88.61 times 125 equals 110 lb. pressure.

If this allowance interferes with the operation of the plant, the patch will have to be replaced by a new one with proper width to give a diagonal efficiency of 82 per cent. This can be calculated as in Problem No. 1.

No. 3—Design of a patch for a water tube boiler. Sections of the plate having a total length of 36 in. (measured at the pitch line) are to be removed on each side of a girth seam. The patch is to be diamond or oval shape. The shell plate is 7/16 in. thick and the longitudinal seam is double riveted butt strap construction, having an efficiency of 82 per cent. What should be the width of the patch for maintaining the same pressure allowance?

Referring to Table I, a single riveted lap seam with 7/16 in. plate, 11/16 in diam. rivet holes, 2½ in. pitch is seen to have a normal efficiency of 56 per cent.

Referring to Table III for "E" equal to 82 per cent and "e" equal to 56 per cent, the Constant "C" is found to be 3.16. Then width W equals C times L divided by 2. Substituting the proper values W is equal to 3.16 times 36 divided by 2 or 56.88, or for good value 57 in.

standardized through the medium of the A. S. M. E. Boiler Code, custom has been standardized somewhat and the maximum length of the patch is of less consequence provided it is designed in accordance with the rules given below. In general the patch should not be longer longitudinally than 20 to 24 in. with a girthwise dimension of about twice the length.

If the patch must be larger than this, or if it requires the removal of many tubes to give access for installation a better proposition is usually offered by a full or part sheet of at least 3/5 of the circumference of the boiler, so that, the longitudinal joints will both come in the space above the tubes with the joints matching the rest of the boiler.

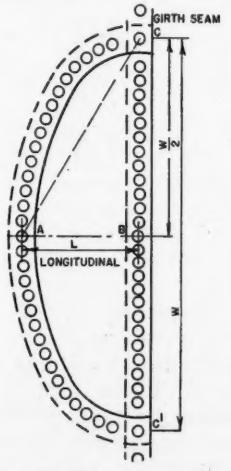


Fig. 5. (Left) A crescent patch applied to the inside of the boiler at the girth seam. For large patches this shape is preferable to the triangular patch shown by Fig. 1. L and W are determined in the same way as for the smaller patch

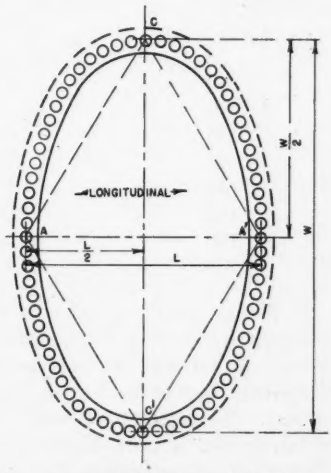


Fig. 6. (Right) An oval patch applied to the inside of the center of the sheet is used for areas larger than practical for the diamond shape patch shown by Fig. 3

In making his rounds, the boiler inspector finds many firesheet patches that show leaks or fire-cracks, due probably to poor workmanship in application. A recent inspection disclosed a patch which had just been put on and which leaked badly at both rivets and seam. The man who did the work wanted to electric seal weld the patch. This, in my opinion, is simply a device for covering up poor workmanship and does not make a permanent job if the patch is not first made tight. In this particular case the patch was refitted, the sheet pulled up tight with bolts in alternate holes and the rivets driven with an air hammer.

Recently a correspondent wanted to know if an autogeneous or fusion welded patch is admissible on a firesheet. In my opinion it just isn't done. Joints held by welding alone do not stand up well under overheating or low water conditions. A rule formulated for locomotive firebox boilers states that any welded joint, as for instance a welded flue sheet segment, should be at least 15 in. below the normal water line. Not long ago I saw the remains of a locomotive firebox boiler that had blown up due to low water and the welded joint at the flue sheet segment, and also a patch at the side of the firebox, had been the parts to let go first. Thus it appears that welded joints do not stand up well under overheating and seal welding is permissible only after the patch is made tight by other means.

Filtering Material for Hot Lime Soda Softeners

Results of tests to determine proper velocity of back-wash water at different temperatures

By J. D. YODER*

HOT LIME SODA softeners are chiefly used for the treatment of boiler feedwater. The water is chemically treated at 212 deg. F., is settled for one hour and then filtered. The filtering material used with such softeners must have several essential characteristics.

It must be insoluble in hot alkaline water and more particularly must not give up any substance which will produce scale in the boiler. It is recognized in practice that this material should be non-siliceous since silica dissolves slightly in hot alkaline water.

It must be prepared to a size that will effectively screen out all insoluble solids from the settled water and will produce what is known as a commercially crystal-clear water.

It must be capable of being cleansed by backwashing with water when supplemented by suitable agitation as with steam or air. The fine material must be kept in place near the top of the bed. It must not pass through the coarse supporting layers.

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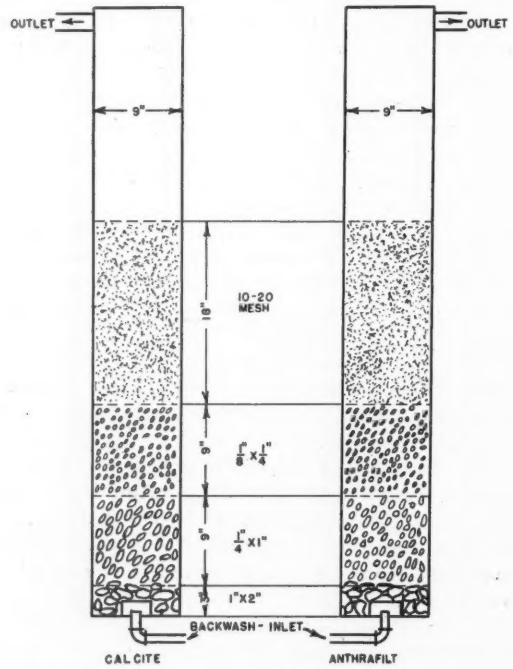

Fig. 1. Test arrangement to determine bed expansion

The customary method of cleansing filter beds is to wash them at a rate sufficiently high to lift slightly the fine grains or to give what is termed a "bed expansion." During such backwashing the bed is hydraulically graded, the fine grains being brought to the top and prevented from passing through the coarse material toward the strainer system.

Obviously the wash water rate must not be high enough to carry off the fine filtering material during backwashing.

To save heat it is customary to wash such filters with hot water from the settling tank and to recover this hot wash water by returning it to the top of the settling tank. The use of wash water at a temperature approximating 200 deg. F. introduces other factors than prevail with the customary backwashing of filters with cold water. The important differences are the lower density and lower viscosity of the water at the higher temperature.

The following table gives density and viscosity of water from temperature of 60 to 200 deg. F.:

Temperature	Density of Liquid	Viscosity of Liquid
Degrees F.	Water lb. per cu. ft.	Water Centipoise
60	62.37	1.129
70	62.30	0.982
80	62.22	0.862
90	62.11	0.764
100	62.00	0.682
120	62.71	0.559
140	61.38	0.470
160	61.00	0.401
180	60.58	0.347
200	60.12	0.305

From the above table it is observed that the water density at 200 deg. F. is approximately 3 per cent lighter than at 60 deg. F., which of itself would call for a slightly higher backwash rate at the higher temperature. The viscosity of water, however, at 200 deg., .305 centipoise, is only 27 per cent of the viscosity at 60 deg., 1.129 centipoise.

The viscosity of water gives it its lifting power as the water flows upward through the fine filtering material. The more viscous the fluid, the greater the friction imposed upon the fine grains and hence its greater lifting power.

In that the viscosity of water at 200 deg. F. is only approximately one-fourth the viscosity at 60 deg. F., it follows that for the same density of filtering material the wash water rate needs to be very much higher for a suitable bed expansion at 200 deg. F. than at 60 deg. F.

Whereas literature (Roberts Hurlbert and Frank W. Herring, Journal American Water Works, Vol. 21, No. 11), on the subject of backwashing sand filters recognizes that a higher temperature water requires a higher wash water rate for equivalent bed expansions, no literature is available for showing wash water rates required to obtain suitable bed expansion with wash water at approximately 200 deg. F. For this reason a series of tests was made to determine proper backwash rates for 200 deg. F. water. These tests were made by preparing filter beds in 9 in. diameter shells, Fig. 1, of the two filtering media commonly used with hot process softeners, viz.—calcite and anthrafilt. Anthrafilt is anthracite selected and prepared for filtration of water. In each case, the beds were made up of sizes and depths of layers frequently used in practice. These beds as illustrated were made up as follows:

3 in. bottom layer of 2 in. to 1 in. size
9 in. second layer of 1 in. to ¼ in. size
9 in. third layer of ¼ in. to ⅛ in. size
18 in. top layer of 10 to 30 mesh, which is the real filtering material.

The upper layer had the following screen analyses:

Calcite

Through 8 mesh on 10 mesh.... 0 per cent
Through 10 mesh on 16 mesh....24 per cent
Through 16 mesh on 20 mesh....46 per cent
Through 20 mesh on 30 mesh....26½ per cent
Through 30 mesh on 40 mesh.... 3½ per cent

Effective size 0.70: uniform coefficient 1.43. Weight per cu. ft. 88 lb. Specific gravity 2.65.

Anthrafilt

Through 8 mesh on 10 mesh.... 0 per cent
Through 10 mesh on 16 mesh....34½ per cent
Through 16 mesh on 20 mesh....47 per cent
Through 20 mesh on 30 mesh....14½ per cent
Through 30 mesh on 40 mesh.... 3½ per cent

Effective size 0.75: uniformly coefficient 1.52. Weight per cu. ft. 43 lb. Specific gravity 1.55.

Both materials had substantially the same screen analysis, practically all of it passing a 10 mesh screen and being retained on a 30 mesh screen. These are screen sizes commonly used in filters with hot lime soda softeners.

Figure 2 shows the results of these tests, whereas the curves do not follow strictly in inverse ratio to the viscosity of the water and its density, they nevertheless have a similar relationship. It was found that a wash rate of 8 to 12 gal. per sq. ft. per min. gave a small bed expansion of calcite at 59 deg. F. whereas to obtain any expansion of calcite with wash water at 198 deg. F. a rate in excess of 22 gal. per sq. ft. per min. was required. This increase in wash water rate requirement is consistent with the lower viscosity and lighter density of the higher temperature water.

Having in mind that to obtain a proper backwash of a filter bed, the rate must be high enough to give a perceptible bed expansion it is obvious that a wash water rate of more than 22 gal. per sq. ft. per min. is required for calcite with wash water at 200 deg. F.

This is a higher wash rate than is commonly used. The rate generally used in approximately 12 gal. per sq. ft. per min. which the curves indicate to be satisfactory at 59 deg. F. As water for washing filters of hot lime soda softeners is generally withdrawn from the sedimentation tank, it is objectionable to backwash filters at 22 gal. per min. per sq. ft. for it causes undesirable disturbance within the sedimentation tank. It is therefore logical to employ a lighter density filtering material in filters used with hot lime soda softeners and as indicated by these curves anthrafilt is very satisfactory for these requirements.

Anthrafilt begins to have a perceptible expansion at

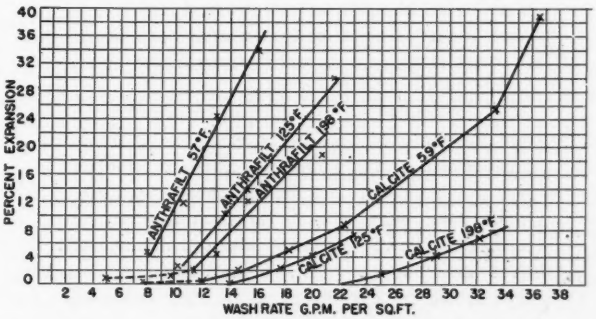

Fig. 2. Bed expansion at varying temperatures and wash rates for anthrafilt and calcite, 18 in. deep bed, 10-20 (commercial) mesh

a wash water rate of 5 gal. per sq. ft. per min. at 198 deg. F. but this expansion does not exceed 2 per cent at a rate as high as 11 gal. per sq. ft. per min. These tests indicate that a wash water rate of 8 gal. per sq. ft. per min. for anthrafilt at 198 deg. F. is sufficient. This observation also conforms with practical experience.

With hot lime soda softeners it is desirable that the backwash be supplemented with steam or air agitation. Steam or air agitation should not be applied simultaneously with wash water, but should precede the water wash. Its primary purpose is to break up the mat of calcium carbonates and magnesium hydrates collected at the surface. These particles are sticky and cling to each other so as to give particles too heavy for wash water to carry them off. If the bed is agitated with steam or air for two or three minutes, this mat is broken up into fine particles which are readily floated off with wash water at a rate of 8 gal. per sq. ft. per min.

If desired higher wash rates may be used with anthrafilt for the curves illustrate that it would require a very high wash water rate to give a bed expansion of 50 per cent with hot water. This demonstrates that there is no likelihood of washing out anthrafilt with a reasonably proper backwash rate for it is recognized in practice that a bed expansion of 50 per cent does not wash out the filter materials.

Where calcite filters are backwashed at rates less than those required to give a perceptible bed expansion (22 gal. per sq. ft.) the hydraulic grading is imperfect. This may permit the fine calcite to work through the coarse sizes and to pass through the strainer system into boiler feed pump.

A further objection to not having a wash water rate high enough to expand the bed is that the pressure loss

(Continued on p. 143)

STEAM POWER— Progress and Problems

At the last annual convention of the Association of Iron and Steel Engineers, Mr. Clarke presented an unusually detailed and comprehensive review of Steam Power Developments and the factors which made recent progress possible. It reflected the thorough analytical ability and wide industrial and central station experience that has made him an outstanding figure in the power industry for many years.

Unfortunately, available space does not permit the paper to be used in its entirety. It was presented from the standpoint of the steel industry and much of the detail covered stations which have been already, or soon will be, described by Power Plant Engineering. These sections have been omitted, so that, this presentation should be considered as a brief discussion of the present status of a few of the more pertinent problems confronting the industry as a whole, rather than as a summary of the complete paper

By C. W. E. CLARKE

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INDUSTRIAL POWER DEMANDS are fast assuming proportions which put the industrial plant more or less in the class of some of the utility plants. With this in mind it is more or less natural that we should look to the modern developments of the utilities as a guide to what can be done for industrial plants in the way of obtaining both reliability and efficiency. In the past 10 yr. boiler pressures, steam temperatures and sizes of boilers and generating units have increased enormously.[1] Pressures are up to 1400 lb. or higher and total final temperatures to 950 deg. F. At about 940 deg. F., we are limited by commercially available materials. While, theoretically, a further increase in steam temperature would result in an increase in the thermal efficiency of the turbo-generator, it is doubtful whether the cost of such an improvement could be justified economically.

Today boilers of 750,000 lb. to 1,000,000 lb. per hr. capacity are not rare and capacities as high as one and a quarter million lb. per hr. have actually been obtained from existing units. It is highly improbable that units of 1,250,000 lb. per hr. will ever be used generally as this size is certainly approaching the condition of "too many eggs in one basket." In the case of turbines, there are several units in actual operation of from 160,000 kw. to over 200,000 kw. capacity.

In general, the larger the steam generating unit installed, the lower in cost the installation becomes per kilowatt of capacity. For the same pressure a boiler of 100,000 lb. capacity costs about twice as much per 1000 lb. of output as does a 1,000,000 lb. boiler. Generating units operating at 3600 r.p.m. are being built as large as 50,000 kw. and manufacturers are at present giving consideration to going as high as 75,000 kw. at this speed. This applies particularly to compound condensing units. It is interesting to note the comparative size and weight of two turbine rotors of the same capacity at speeds of 3600 and 1800 r.p.m. The 3600 r.p.m. rotor is 80 in. in diameter over the last blades, 6 ft. 5 in. long and weighs 23,000 lb., while the 1800 r.p.m. rotor is 110 in. in diameter over the last blades, 8 ft. long and weighs 108,000 lb. Coincident with these changes there has been a substantial increase in the overall efficiency of the generating plant. With the steam cycle of today it is entirely feasible to obtain overall plant thermal efficiencies of about 30 per cent.

The influence of increased pressure and temperature on heat consumption of the turbo-generator and on the station heat rate per kw-hr. is illustrated by Fig. 1. It will be noted that while the prime mover in itself continually attains better efficiency with increased pressure and particularly with the higher temperature, the overall plant efficiency, assuming 1000 deg. F. as being present day maximum allowable temperature, shows little or no gain to be expected above 1400 lb. unless reheating is resorted to for these higher pressures. The difference in the shape of the curve of the turbine as against the complete plant is due to the requirements of the auxiliaries, particularly the power needed for pumping feed water.

These tremendous advances have been made possible by several factors. Development of chrome, nickel and molybdenum alloys has allowed a construction (in machines, piping connections and other pressure parts of the generating plant) which copes with the increased stresses and which permits the safe use of the high pressures and temperatures. Improvement in the welding art and manufacturing processes has been extremely

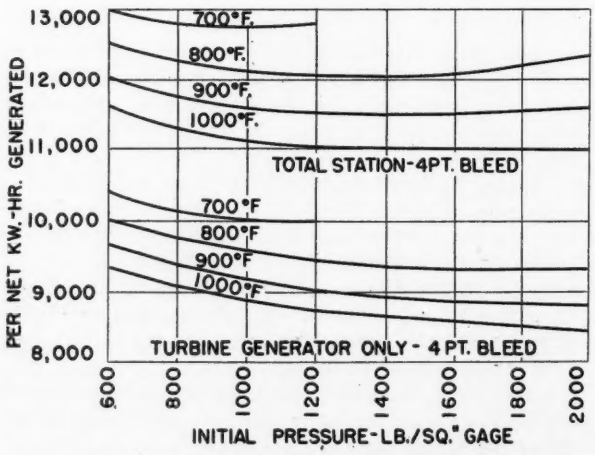

Fig. 1. Variation of heat rate for different initial pressures and temperatures. The difference in the turbine and total station heat rates and the shape of the curves is due to the auxiliary load, particularly the feed pump load which increases rapidly with pressure

[1]For data on these trends see Superposition by C. W. E. Clarke, Power Plant Engineering, p. 215, April, 1937.

effective in promoting efficient production, not only of boiler parts, but, of piping systems. Welding-in of valves obviates the need for flanged joints which, under the higher temperatures, are apt to require considerable maintenance due to the creep stresses in the joint bolting material. Better knowledge of the physical properties of steam has also played a part.

Boilers

Increases in steaming capacity, steam pressure and steam temperature has caused many changes in boiler design. In this country these changes were not fundamental, but consisted rather in rearrangement of heat absorbing surface, the use of water-cooled walls, superheat control, welding of steam drums, air preheaters, pulverized coal, new ways of removing ash and similar changes to parts of the steam generator. Steam drums and thermal water circulation are still used practically without exception. Today water-cooled furnace walls are almost universal because, while protecting the wall structure and reducing maintenance, they also permit a considerable heat absorption and steam generation in the wall surface.

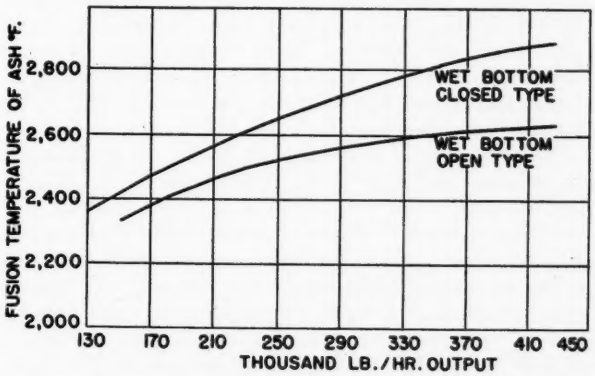

Fig. 2. Boiler ratings are limited by the type of furnace and fusing temperature of the coal ash. These curves were drawn for a 430,000 lb. per hr. boiler

Pulverized-Coal Firing

Burning coal in pulverized form has made rapid strides. There are two types of furnace bottom in general use with pulverized fuel firing. One is the so-called dry-bottom which disposes of the pulverized fuel ash in dry granular form. This design is particularly advantageous for coals with ash of high fusion temperature. The other type, the so-called wet-bottom, is a furnace wherein the temperature in the combustion space is kept high enough to liquefy the ash. This type of furnace is particularly applicable to the poorer grades of coal, although, there are a number of installations where it has been used with ash having a fusion temperature as high at 2700 deg. F.

The wet-bottom furnace has some advantages in that it does entrain a certain amount of fly ash which would escape from a boiler with a dry-bottom, but it also has distinct limitations in the ratings at which the boiler can be operated, particularly in the lower operating ranges and when using fuels with fusion temperatures of 2300 deg. F. and above. This is shown in Fig. 2. Note that this curve illustrates two types of wet-bottom designated as "closed" and "open". Richmond Station[2] of Philadelphia Electric Co. was one of the forerunners of the closed wet-bottom and used a vertically-fired unit with a water screen across the top of the combustion space considerably below the heating surface, more or less isolating the combustion space from the furnace proper. Successive changes brought this to a real closed-type as in the Fisk Station[3], Commonwealth Edison Co., where the slag screen has been placed vertically.

Turbo-Generators

Principal advances in the design of turbo-generators have been: increase in the size of units, higher speeds, the greater efficiency due in a great measure to the increased pressures and temperatures at which they operate. The double-wall cylinder construction for high-pressure high-temperature turbines, shown in Fig. 3, is of interest. The space between the walls is subjected to bleeder pressure and so the pressure differential from the inside of the turbine to the jacket is reduced. This permits the use of thin cylinder walls and reduces the stresses in these walls due to uneven heating in starting and in changes of load. The radiation losses from the cylinder are also reduced since the extraction steam in the jacket is at lower temperature.

Feed Heating

Unless steam-driven auxiliaries are highly desirable for a specific reason, feed-water in the modern plant is heated with steam bled from the turbine. This permits the maximum of energy to be extracted from the steam before it is used for feed heating. The heating is done progressively from condensate temperature to boiler feed temperature in steps of about 60 to 70 deg. F. The more heating stages used, the better the thermal efficiency of

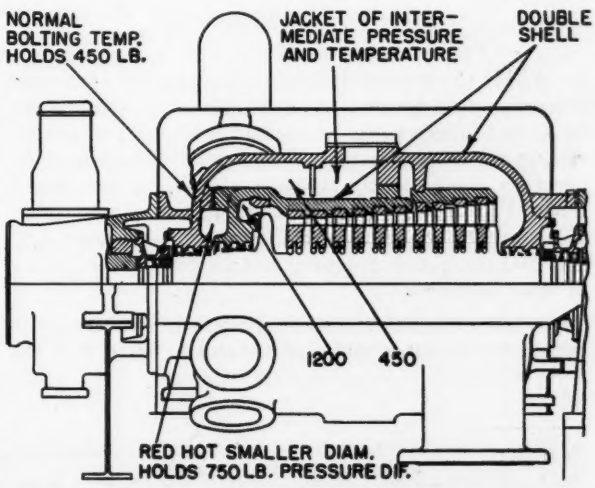
NORMAL BOLTING TEMP. HOLDS 450 LB.
JACKET OF INTER-MEDIATE PRESSURE AND TEMPERATURE
DOUBLE SHELL
1200
450
RED HOT SMALLER DIAM. HOLDS 750 LB. PRESSURE DIF.

Fig. 3. For high temperature, high pressure turbines a double shell construction of this type is used to reduce stresses and strains in the castings

[2]See Fig. 3 of the article New 165,000 kw. Addition At Richmond Station by N. J. Walker, W. B. Morton and H. Groothuis, Power Plant Engineering, p. 434, August, 1935.

[3]See Fisk's New Top Program Increases Capacity 30,000 kw., Power Plant Engineering, p. 576, October, 1937.

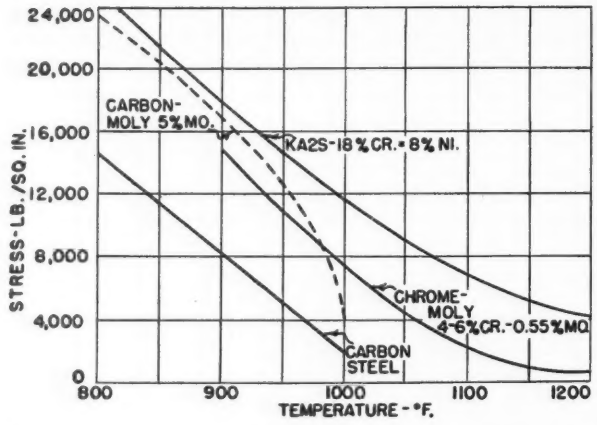

Fig. 4. For high temperatures alloys must be used. These curves show the creep strength of four popular alloys based on one per cent deformation in 100,000 hr.

the plant. However, the gain in thermal efficiency must be balanced against the cost to obtain that efficiency. It is for this reason that we find new plants being designed with three, four, or more stages of feed heating, selection depending on careful calculations in regard to efficiencies and costs.

Since extraction heating has become prevalent, closed feed-water heaters have been used nearly exclusively and have given very satisfactory service. The principal complaints have probably been the occasional cracking of the heat-transfer tubes, corrosion due to air entrained with the bled steam and leakage at the joints where the tubes are rolled in the tube sheets.

Open vs. Closed Heaters

Within the present decade a new design of heater for extraction feed heating has been marketed, wherein the steam is brought in direct contact with the feed water, raising the water temperature to saturated steam temperature. This slightly higher feed temperature (about 3 deg. F. for every stage of heating) means a considerable fuel saving annually. However, the higher first cost and the higher pumping cost may offset this saving in some instances.

In this design the water is sprayed in each heater to get direct contact with the steam and to bring it to the saturated-steam temperature. Each heater requires a pump to remove the heated water from the heater and discharge it to next heater. To secure proper regulation all of the heater pumps should be driven by a single motor or turbine. This extra pumping equipment is thought to be objectionable by some operators. The vents are passed through vent condensers before being cascaded back to the lower-pressure heaters and are finally discharged into the condenser.

Piping

These heaters have given good results although trouble has been experienced with water hammer and with cavitation in the removal pumps, requiring frequent replacement of impellers. Much of this trouble is being or has been corrected by keeping the impeller submerged. Comparative heat-flow diagrams are shown in Fig. 5 for contact and closed heaters.

With the rapid advance made in the art of welding, power plant designers have not hesitated to take advantage of using welded joints in pipe lines, even for the most severe service. Experience has shown that welded joints, made by qualified workmen under adequate supervision, are entirely dependable and eliminate all trouble experienced with flanged joints, such as leaks due to uneven expansion and change in physical characteristics of bolt material due to repeated stresses or to being stressed above the elastic limit of the material. Steel valves are being welded in high-pressure lines and state boiler inspectors in some instances have permitted the welding of valves to the pressure parts of the boiler without X-raying, although that is not yet permitted by the A.S.M.E. Boiler Code. In many cases the entire steam line between the superheater and the turbine throttle are being welded with no flanged joints at all in the pipe line.

Special Alloys

Present-day trends towards higher temperatures and pressures have necessitated special attention for pipe lines and valves with their requirements for new types of material, special alloys, etc. Although several alloys are suitable for this service, in the past they have not been commercially available as seamless pipe and in the

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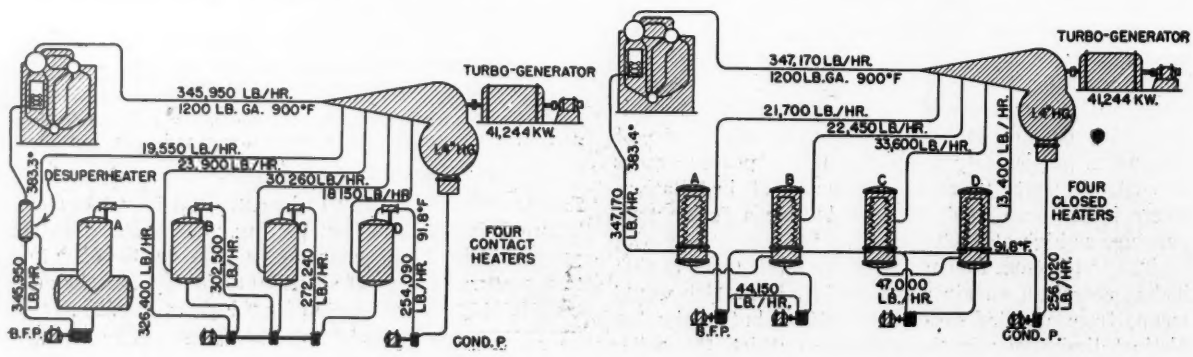


Fig. 5. Flow showing the comparative performance of open (left) and closed (right) heaters for four stages of extraction, initial steam conditions and electrical output being the same in both cases

Murray Iron Works Co. introduces the Type U, a new line of small turbines taking its type name from the shape of the lower casing. Splitting the casing horizontally above the shaft, gives room in the lower casing for an unusually large arc of steam admission to the wheel with its attendant advantages. Sizes range from 25 to 1000 hp. and the design can be used for a wide range of pressures and temperatures up to a maximum of 600 lb. per sq. in. and 750 deg. F. total temperature. These limits can be extended as desired by modifications in the design and materials of the steam chest

MECHANICAL DRIVE TURBINES

By C. F. Jensky
Chief Engineer
Murray Iron Works Co.
Burlington, Ia.

SMALL STEAM TURBINES in the classification usually referred to as mechanical drive turbines, operate under a wide range of conditions peculiar to this class of machinery. The process of evolution has necessarily played an important part in the successful development of turbines to meet these varied conditions. Apparently dinosaurs were also a product of the process of evolution and faced a wide range of conditions. The only trouble was that they quit evolving and became but a symbol of a bygone age.

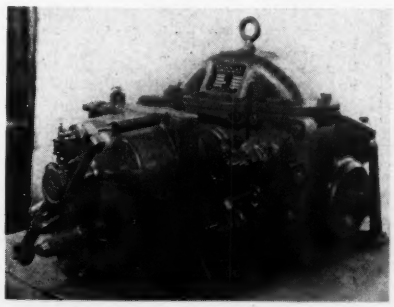
Mechanical drive turbines, like their big brothers, continue to hold their important position in the power field by keeping abreast of new developments in materials, manufacturing equipment, manufacturing methods and operating conditions. From an examination of new designs recently placed on the market, it is evident that mechanical drive turbines are receiving their share of the designing engineer's attention. The following description of new models, recently introduced by the Murray Iron Works Co. of Burlington, Iowa, is an indication of active development work in this field.

General Considerations

Because the lower half of the casing resembles the letter U, these turbines are designated as Type U Mechanical Drive Turbines. They are built in various sizes to cover the range from 25 to 1000 hp. and operate at speeds of from 1000 to 5000 r.p.m. These turbines are of the single stage, velocity compounded impulse type with either two or three moving rows of buckets as dictated by operating conditions. While retaining the rugged simplicity of mechanical drive turbines in general, the new design embodies a number of interesting new features. The general appearance of these turbines is shown in Fig. 1, 2 and 3.

In the past it has been found desirable to split the turbine casing horizontally so that the rotor could be removed and the machine generally dismantled without disturbing the main from or breaking high pressure steam or exhaust connections. With increasing pressures and temperatures, this became even more desirable. While very practical from an operating standpoint, this requirement imposed undesirable restructions upon the designer.

In the first place, the entire upper half of the turbine was wasted as far as steam admission space was concerned. Furthermore, only a small portion of the lower half was available for steam admission due to space required for the bolting flanges. This was especially burdensome on the smaller sizes. In the new Type U turbine the rotor may be removed without



Figs. 1, 2 and 3. Left, front view showing arrangement of hand valves and overspeed trip mechanism, the details of which are shown by Fig. 5. Middle, quarter view showing governor, steam chest and casing arrangement. Right, rear view showing the exhaust and turbine support

distrubing the steam inlet or exhaust piping, or, breaking any high pressure steam joints, but at the same time a large steam admission arc is available.

Details of Construction

The chief distinguishing feature of these new turbines is the casing arrangement. The casing is split horizontally an appreciable distance above the center of the shaft. This construction provides the following desirable features:

a. **The horizontal casing bolting flange, being well above the center of the shaft, makes available a large arc of steam admission to the wheel. This provides a flexible design to meet various steam conditions and an efficient nozzle arrangement.**
b. **The large arc of steam admission provides ample space for hand valves. The hand valves are very accessible so that they may be used to the maximum degree to obtain good efficiency under various operating conditions.**
c. **Ample room for steam inlet and exhaust openings is available because the horizontal flange is well up out of the way. Therefore, the sizes of these openings need not be restricted at the expense of efficiency.**
d. **The turbine cover in effect becomes a blind flange. It is comparatively small and can be removed by unskilled hands for internal inspection of the turbine without in any way disturbing the mechanical condition of the machine.**

Another feature characteristic of this design is the casing arrangement at the exhaust end. The exhaust outlet is kept in the usual low position for proper draining. Long sweep exhaust steam passages are provided opposite the upper nozzles on each side of the wheel. These sweeping passages assure uncrowded exhaust steam flow from the buckets to the exhaust opening, and thus further contribute to efficient operation.

This arrangement is possible because of the generous space provided by the unusual position of the horizontal flange. These exhaust passages are also utilized to provide centerline support of the hot casing at the coupling end in order to maintain shaft alignment under all operating conditions. The casing is doweled to the well-ventilated support with a sliding dowel located on the transverse centerline. The general arrangement is shown in Figs. 1 to 4.

The steam chest containing the main governor and overspeed governor valves and the steam distribution ring containing the nozzles and hand valves are combined in an integral casting. The steam distribution ring for maximum steam admission is also shaped like the letter U. High pressure inlet steam is confined to this casting. The steam chest assembly is bolted to the front of the turbine casing as shown in the various illustrations.

Modern Materials

The general arrangement of the remaining features follows conventional lines. The individual parts, however, have been designed to take full advantage of modern materials and construction methods. Such matters as protection against dust and other foreign material, effective oil sealing, lubrication, accessibility and interchangeability of parts have received the same careful treatment accorded larger units.

The detail material specifications for one of these turbines looks far different from its predecessor of the "good old days" when the words "cast iron" and "steel" served the purpose. The applications and operating conditions which single stage turbines are required to meet are extremely varied. Great flexibility

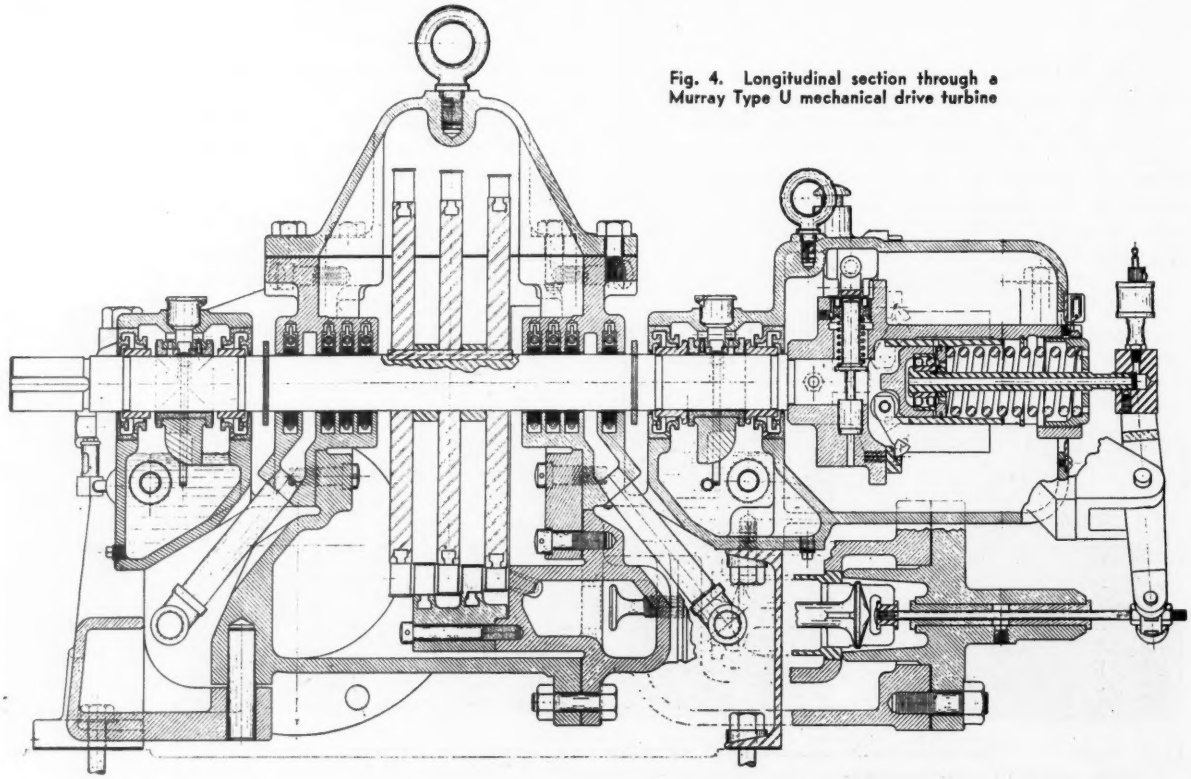


Fig. 4. Longitudinal section through a Murray Type U mechanical drive turbine

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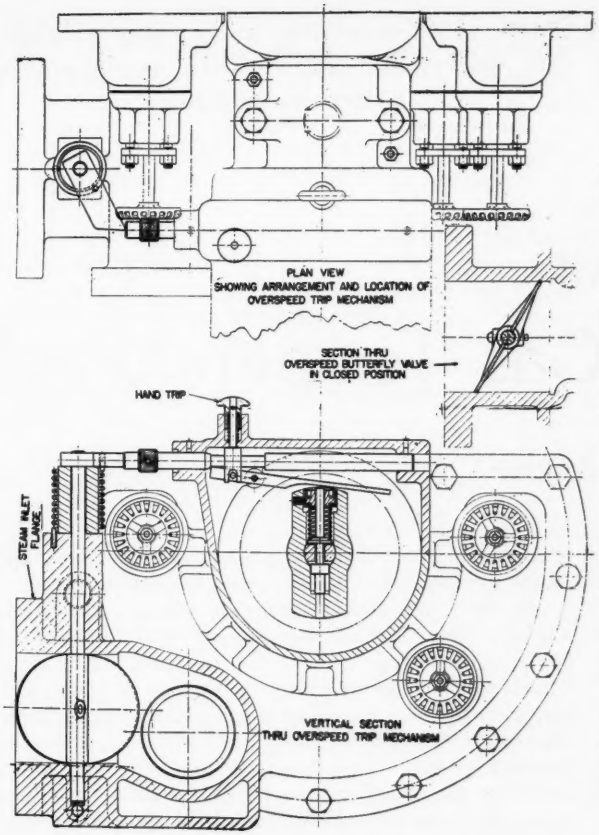


Fig. 5. Details of the overspeed trip mechanism

in design is essential to eliminate "misfits" or the alternative of an uneconomical number of different frames. In this case the desired result is obtained by making the component parts interchangeable to a great extent and carefully designing each part for manufacturing efficiency.

By planning the essential manufacturing operations and designing special tools and fixtures simultaneously with the general design work, a well-balanced design was achieved. Mechanical drive turbines tailored to suit a wide variety of individual applications are thus economically produced from basic stock parts.

Table showing the applications to the new line of turbines of some new materials and construction features developed during the past few years

MATERIAL	APPLICATION
Corrosion resisting steel. Various types.	Moving and stationary buckets. Bucket shrouding. Hand valves. Hand valve seats. Steam nozzles. Governor valve stem. Overspeed valve shaft. Steam strainer. Carbon gland springs.
Heat-treated aluminum alloy castings.	Governor head.
Hard-facing electrodes.	Governor valve and cage seats. Governor parts.
Hollow head alloy steel cap screws.	Bearing brackets. Steam chest. Gland cases. Stationary blade segment.
Centrifugally bonded bearing linings.	Babbitt-lined main bearing.
Special high pressure, high temperature steam gasket material and construction.	Hand valve body gaskets. Steam chest gaskets.
Helical fin tubing.	Bearing oil coolers.
Alloy and heat-treated steels.	Rotor shaft. Rotor discs. Main and overspeed governor part.

sizes required for power plant construction. Through the combined efforts of the manufacturers and the consumers, progress has been made, and it is now possible to obtain carbon molybdenum pipe in sizes up to 14 in. outside diameter.

It was mutually agreed to concentrate on the manufacture and use of carbon molybdenum alloy because in fabrication, this material appears to give the least trouble of all the ferrous alloys suitable for high-temperature service; also manufacturing is simplified by the concentration on only one alloy. Figure 4 shows that the creep strength of this alloy is more than twice as high as carbon steel at 950 deg. F. and approximately as good as the higher chrome alloys. This means that wall thickness of carbon-molybdenum need be only ½ the thickness of carbon-steel pipe at 950 deg. F. Cast-steel valves can be obtained in almost any alloy desired but carbon molybdenum has an advantage in that the use of similar alloys in the pipe and the valves simplifies the welding.

It is considered good policy that all welders employed to weld high-pressure piping be tested and qualified by a reliable agency such as one of the Boiler Inspection and Insurance Companies and that the same agency inspect all shop and field welding. In this way, good workmanship is obtained, one of the most important items of a successful welding job.

Whether or not completed welds have dangerous internal stresses in the material at the weld has not yet been definitely proved. Recent tests indicate that internal stresses of serious proportions exist in non-stress-relieved welds. It is, therefore, still considered good practice to relieve such stresses as far as possible by slowly heating the welded joint to a temperature between 1150 and 1200 deg. F. and thereafter cooling slowly. This stress relieving is considered very important in alloy-steel piping and is also applied to fabricated piping in order to relieve stresses set up in the fabrication of pipe bends.

Materials which are subject to air hardening, such as alloy steels and carbon steel, with a carbon content above 0.30 per cent should be preheated before welding is started, the temperature of the preheat depends somewhat on the characteristics of the metal, but in general 400 deg. F. to 600 deg. F. is found to be satisfactory. Because of better temperature control it is desirable that both stress relieving and preheating be done electrically.

In line with the desire of power plant designers to eliminate bolted joints, valve manufacturers are now experimenting with designs for holding the valve bonnet to the body by means of special joints, either eliminating bolts in tension or reducing the stresses on the bolts which hold the gasket. This work is still in the development stage, but is a step in the right direction.

Valve discs and seats for high-pressure, high-temperature valves are generally constructed of stainless steel; if the temperature is above 850 deg. F., the stainless steel is usually faced with Stellite, a cobalt alloy, which is fused on. For temperatures below 850 deg. F. stainless steel or copper-nickel alloy facings can still be used satisfactorily. In order to eliminate leakage past the threads of screwed-in seats, it is now quite customary to weld the seat to the valve body.

Opinions differ among authorities, a condition decidedly confusing to engineers in charge of operation.

Does Preheated Air Decrease Flue Gas Temperatures?

By J. R. DARNELL

RECENTLY in a discussion with several other engineers, the question arose as to whether or not preheated air used for combustion could cause a decrease in flue gas temperature.

It is known that high CO_2 lowers flue gas temperature in spite of the increased furnace temperature. This was explained graphically in the Question and Answers section of Power Plant Engineering page 341, March, 1926. It has been found that the rate of heat transfer, chiefly by primary radiation, caused by the temperature of the incandescent fuel bed (or flame alone in the case of gas or oil firing) increases approximately as the difference of the fourth powers of the furnace temperature and of the boiler tube temperature. This is in accordance with the Stefan-Bolzmann law of radiant heat transfer.

Whenever the amount of excess air is reduced and this results in increased CO_2 and higher combustion temperature, a lesser amount of heat will be carried from the furnace by hot gases, particularly since the gases themselves transfer heat by radiation. Although oxygen and nitrogen do not radiate heat, the proportion of these gases decreases as the excess air is reduced while CO_2 and water vapor which do have the power to radiate are less diluted by non-radiating gases. This means that although the rate of heat transfer by convection through the tube bank is decreased due to the lower weight of gases when operating with higher CO_2, the increased percentage of CO_2 increases the heat transfer by radiation sufficiently to give a lower exit temperature than with lower CO_2.

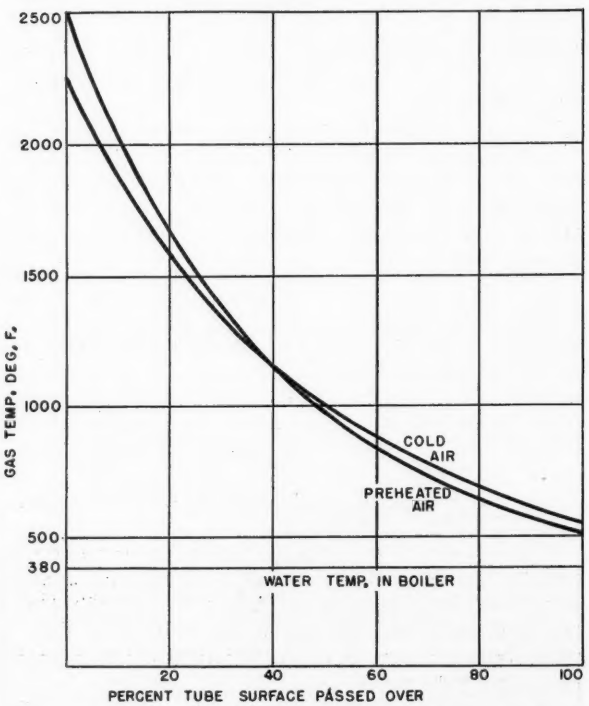
Effect of Preheated Air

With the above conditions in mind, let us now consider what happens when preheated air is used for combustion. Engineers who should be in a position to know, appear to have widely divergent opinions. Haslam and Russell in their book "Fuels and Their Combustion," 1926 edition, page 294, in discussing the effects of preheated air, state:

"All combustion reactions are speeded up by increasing the temperature and therefore with preheated air it is possible to burn fuel completely with much less excess air than would be required if cold air were used."

On the other hand, in the November 1, 1930 issue of Power Plant Engineering, page 1251, D. J. Mosshart, engineer for a large stoker company says: . . . "inspection of the data from a number of tests with both cold air and preheated air shows very little justification for the statement that preheated air reduces the temperature of the gases leaving the boiler."

If the use of preheated air does not reduce the temperature of the gases leaving the boiler it must follow: (1) that, contrary to Haslam and Russell, it is not possible to burn fuel completely with less excess air when using preheated air or (2) that, in the tests to which Mr. Mosshart referred, the operators did not attempt to



Initial temperature of products of combustion is higher but final temperature lower when using preheated air. (Cochrane Corp. Handbook [1928 edition, page 549])

*Consulting Engineer—Jenkins Petroleum Process Co. and Donnelly Process Corp.

learn whether or not it was possible to obtain the same boiler output with lower excess air when the air was preheated. If they did not attempt to use less excess air with preheated air, then of course there was no change in the percentage of CO_2 and no increase in furnace temperature above that which would normally be due to the sensible heat returned to the furnace by the hot air.

A library search of technical literature on this subject indicates that little has been written which will throw much light on the question as to which factor has the most influence on flue gas temperature: (a) initial temperature of the gases entering the tube bank (b) weight of gases (c) quality of the gases, that is, the amount of carbon dioxide and water vapor present. One authority offers the following explanation:

"The introduction of preheated air increases the initial temperature of gas leaving the furnace, but seems also to result in an increased temperature at the boiler exit. In this case the excess air and CO_2 are unchanged. While radiation from the fuel bed and from the gas stream increases with the increased initial temperature, the dilution of radiating gas with non-radiating gas is unaltered and as a result the gas radiation is not as great as if the CO_2 were increased.

"Also there is little reduction in the weight of gases when using preheated air, hence the velocity of the flue gas passing through the nest of tubes is unchanged. The heat transferred from each pound of gas by conduction is, thus, not greatly different and if the gases enter at a higher than normal temperature, they leave likewise at a higher than normal temperature."

Proponents of preheated air will argue that the flaw in the above statement is the assumption that the excess air and CO_2 are unchanged. To support the argument that preheated air does promote more rapid combustion, hence requires less excess air, one may refer to numerous authorities such as the Prime Movers Committee Reports of the National Electric Light Association, now known as the Edison Electric Institute (see 1928 report) and various text books on combustion.

In the book "Finding and Stopping Waste in Modern Boiler Rooms," 1928 (3d edition) Fig. 1, page 549, shows a lower exit temperature with preheated air. Starting with a furnace temperature of 2500 deg. with preheated air, and 2250 deg. with cold air the curves drop to about 1100 deg. after about 45 per cent of the heating surface has been passed, crossing each other at this point. Leaving the tube bank, the preheated air curve shows about 500 deg. while the cold air performance gives a final temperature of 550 deg., notwithstanding that it started 250 deg. lower. No mention is made as to any changes in CO_2 when preheated air was used.

On this same page, the following statement corroborates Haslam and Russell:

"In addition to the theoretical gain by returning the heat to the furnace, the higher furnace temperature should lead to more efficient combustion, with less carbon in the ash, with the use of less excess air; and to better heat transfer, both by radiation and from contact of gas with metal."

From the foregoing it is conceivable that we might burn fuel with cold air to produce a furnace temperature of, say, 2500 deg., with 14 per cent CO_2 and get a flue gas temperature of 500 deg. While in another case, using preheated air we might start with the same furnace temperature or even somewhat lower but get a higher exit temperature if the CO_2 was lower, say 10 to 12 per cent. One conclusion which may be drawn is that the mere use of preheated air does not vaccinate operators from the effects of careless firing. On the other hand if full advantage is taken of the fact that preheated air will permit more intense and rapid burning which makes possible complete combustion with much less excess air, I believe that careful tests will show lower exit temperatures when using preheated air. It is hoped that readers having information on this subject will contribute to the discussion.

Filtering Material for Hot Lime Soda Softeners

(Continued from p. 135)

builds up too rapidly after backwashing. It is probably for this reason, as has been found by experience, that an anthrafilt bed produces less pressure loss in filtering a given quantity of hot water than is produced by a calcite filter when washed at the rate of 12 gal. per sq. ft. per min.

Whereas these tests clearly indicate that calcite is not so well adapted as anthrafilt for hot process softeners, if used as a fine filtering medium, it is a good material for the coarse sizes which serve for distributing the wash water and supporting the fine filtering material. The fact that calcite is so little disturbed by washing with hot water favors its use as a supporting medium.

One of the important qualifications of the supporting medium is for it to stay put.

Coarse sizes of filtering beds have been known to shift or to form what has been described as "gravel hills". When these "gravel hills" are formed the depth of the fine filtering medium is not the same throughout, which sets up non-uniform water distribution and results in improper washing.

If a filtering medium of lighter density, as anthrafilt, is used for the upper layer, and a wash water rate is maintained only high enough to give a slight bed expansion, it follows there is very little likelihood of shifting calcite if used for the supporting layers.

In conclusion, these tests have demonstrated the desirability of using a lighter density filtering material for hot process softeners than may be used for cold water and that anthrafilt has a proper density for the fine size. Anthrafilt is subjected to a suitable bed expansion at a moderate backwash rate, and it is not light enough to be carried off with the wash water. Calcite is a good material for the coarse supporting layers for it securely holds its position.

PATENT covering the manufacture of rubber and flexible bladed fans has been granted to A. O. Samuels, president of the Samson-United Corp., Rochester, N. Y., an improvement which does away with wire guards, abolishes danger and eliminates much noise. Like patents have been granted in principal European countries, and Mr. Samuels states that arrangements may soon be made to license other manufacturers.

General Motors New Diesel Program

Complete line of lightweight, two-cycle engines from 55 to 1200 hp. to be produced in three factories. New Detroit factory now producing the Model 71 series, in one to six cylinders, 55 to 160 hp. maximum at 1800 r.p.m., Cleveland factory will produce the Model 223 series, four to eight cylinders, 200 to 400 hp. and the new La Grange factory the present line of engines ranging from 600 to 1200 hp. Development work will be centralized in new Detroit Laboratory.

COMPLETION of the new factory for the Detroit Diesel Engine Div. of General Motors Corp. marks the first step in the corporation's program to produce a complete line of Diesel engines ranging from 22 to 1200 hp., by modern production methods perfected in the automotive field. This new plant, on a 75 a. tract at the Pere Marquette Railroad and the Outer Drive, is laid out for a production of 50 engines per 8 hr. day and production was started late in January. The development also includes a new Diesel Laboratory, in which all Diesel development will be centered and which is said to be the largest and most completely equipped unit of its kind in the world devoted exclusively to Diesel engine study.

Larger sizes including the 8, 12 and 16 cylinder engines from 600 to 1200 hp., with 503 cu. in. displacement per cylinder, at present being built for railroad, marine and stationary service, at the Cleveland Diesel Engine Division (formerly the Winton Diesel Engine Mfg. Corp.) will be moved to a new factory being built at the Electro-Motive Corporation's locomotive plant at La Grange, Ill. When this factory has been completed the Cleveland Div. will produce the intermediate size engines, the model 223 series with four, six and eight cylinders of 223 cu. in. cylinder displacement units ranging from 200 to 400 hp.

An additional feature has also been assigned to the Cleveland plant, the assembling of equipment on all sizes of engines for the so-called "power packages." This will relieve the customer of assembling necessary appurtenances such as special foundations, fuel supply systems, water cooling systems and muffling equipment. The engines will arrive complete and ready to operate.

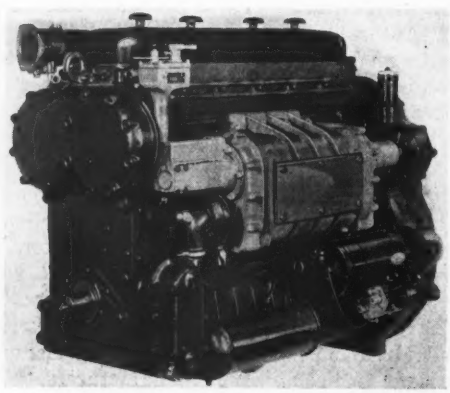
The new Detroit factory will produce the smaller engines built up of 71 cu. in. displacement cylinders. Specifications for the three larger size units are shown by the accompanying table.

Cylinders are cast en block with removable dry liners and the cylinder head is a one-piece removable unit with overhead valves. Valves are operated through rocker arms and push rods from a camshaft, located in the upper part of the cylinder block, and driven by a train of gears which also drives the blower. The water pump, fuel transfer pump and governor are mounted on the blower and driven by it. The blower is flanged mounted on the side of the cylinder block and discharges directly into the air box. Inlet ports, through the liner and water jackets at the bottom stroke position, connect the cylinder to the air box surrounding the cylinder proper as the ports are uncovered by the piston. The oil pan and valve covers are one piece pressed steel units. Fuel is sprayed into the cylinder by a combined pump and spray nozzle or unit injector located between the valves in the cylinder head and operated from the camshaft by a rocker arm, like the exhaust valves.

A new design feature provides for balancing the small fore and aft rocking couple which results from the uniform firing of all cylinders each revolution. This is done by small counter-weights at each end of the camshaft, and a second similar shaft on the other side of the cylinder block.

Cylinders are the same size for all models in the 71 series. The front end of the cylinder block of all models is the same as the rear end, as are the cylinder head, blower, bearings, etc. Pistons, valve gear, connecting rods, bearings, pumps, timing gears, flywheel housings, etc., are identical for all models and completely interchangeable. The machining dimensions of all cylinder blocks and heads are identical except for length.

The entire cylinder block and blower assembly can be turned end for end without disturbing the flywheel or gear train so as to place all the accessories on the opposite side. The cylinder head can also be reversed regardless of the position of the blower so as to place the exhaust and water manifolds on either the opposite side or the same side as the blower. By shifting one gear in the gear train, and changing the camshaft and oil pump cover, the rotation of the crankshaft can be made either clockwise or anti-clockwise with any of the above accessory arrangements. The generator and air com-



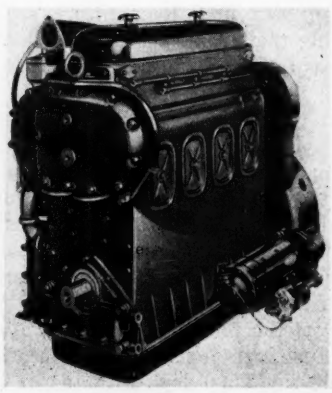


Fig. 1 (Left). Blower, pumps, governor and oil cooler mounted on the side of a six cylinder Model 71 engine. The crankshaft may revolve in either direction and the cylinder block is reversible end-for-end so that exhaust and water manifolds and accessories may be grouped on either side Fig. 2 (Right). Four-cylinder Model 71 engine with the blower, pumps, governor and oil cooler grouped on the far side. The new line of engines are designed to use ordinary S.A.E. 30 lubricating oil in summer and S.A.E. 20 in winter

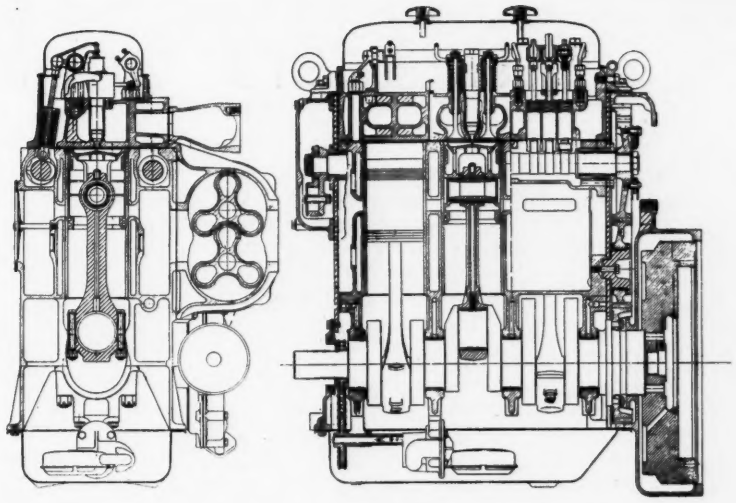


Fig. 3. Cross sections through a three-cylinder Model 71 engine. This line of engines ranging up to six cylinders and 160 hp. is designed on the basis of quantity production, complete interchangeability of parts and modern factory production. The flexibility of design with but few right and left hand parts results in eight distinct models for each engine size

pressor, or vacuum pump, can be mounted over the gear housing and driven direct from the cam and balance shafts, or attached to the side of the crankcase and belt driven. The fuel injectors are identical for all models. All these assemblies can be made with but a few right and left hand parts, the result being eight distinct models of each engine size.

It is obvious that this similarity of parts and the reduction in the number of different kinds of parts has had a marked effect on the production machine and tool set up. Many of the machines and fixtures take the parts for all models. This permits volume production methods to be applied where the number of models would otherwise make the tooling cost prohibitive.

The new Detroit plant is the focal point for coordinated engineering and test facilities for all plants in the new set-up. The engineering department designs all Diesel engines developed for the Corporation while the testing laboratory contains personnel and equipment for carrying on this work for the entire group. The factory proper consists of a monitor-type structure, 240 ft. in width and 480 ft. in length, of the latest factory building construction with the maximum of window glass area.

Following the pattern of planning in other departments of the new Diesel organization, the laboratory has been designed as a central testing set-up, serving all Diesel engine divisions of the Corporation. Consequently, its equipment includes facilities for testing all sizes of engines from the very smallest to the largest. In excess of 4000 horsepower will be in continuous operation in the building.

The building proper is about 105 ft. wide and 223 ft. deep at its widest section. It is of vibrated concrete construction with a rounded modernistically-styled front office entrance. The latter is two stories in height. It is unique in the fact that it combines the functions of a self-contained power plant serving both the laboratory and factory with heat and power, together with unparalleled testing facilities.

Profiting by the experience of other large-scale laboratories and taking advantage of the latest scientific discoveries in the field of accoustics the designers have created a set-up in which noise and vibration are brought completely under control. Each engine foundation rests on an individual concrete platform with its own set of piles extending into the ground. Consequently, every piece of equipment in which there is motion is effectively isolated from the building and other units. Normal noises in the new laboratory are held to a low level by the use of sound-proofed and sound absorbing wall and ceiling surfaces.

The power plant comprises a boiler room and a power department. The boiler room contains a modern oil-fired boiler as well as an electrically heated boiler. The power department contains three main Diesel-electric stationary generating units powered by an eight-cylinder, a twelve-cylinder, and a sixteen-cylinder G.M. Diesel engine, respectively. The eight and twelve cylinder units generate at 550 v. d.c., the engine, at 4600 v. a.c. The power section also contains a three-unit motor generator set, power distribution switchboard, and power transformers. The a.c. power line is stepped down by transformers in the laboratory building and in the main plant to 440 and 110 v.

Table—General specifications of the three larger sizes of the Model 71 engine

	Model 3-71	Model 4-71	Model 6-71
Number of cylinders	3	4	6
Bore and stroke, inches	4-1/4 x 5	4-1/4 x 5	4-1/4 x 5
Total displacement, cubic inches	212.69	283.58	425.37
Maximum hp. output at 1800 r.p.m.	80	107	160
Continuous hp. rating at 1200 r.p.m.	45	60	90
Continuous hp. rating B.m.e.p., lb./sq.in.	70	70	70
Maximum torque, lb. ft. at r.p.m.	283 600-1000	375 600-1000	562 600-1000
Compression ratio	16:1	16:1	16:1
Piston speed-ft./min. at 1200 r.p.m.	1000	1000	1000
Number of exhaust valves per cylinder	2	2	2
Exhaust valve diameter, inches	1-11/16	1-11/16	1-11/16
Exhaust valve seat angle, degrees	45	45	45
Exhaust valve lift, inches	0.375	0.375	0.375
Firing Order (Clockwise (cranking) rotation	1-3-2	1-3-4-2	1-5-3-6-2-4
Firing Order (Counter clockwise rotation	1-2-3	1-2-4-3	1-4-2-6-3-5
Number of main bearings	4	5	7
Main bearing diameter, inches	3-1/2	3-1/2	3-1/2
Main bearing length, inches	1-1/8	1-1/8	1-1/8
Main bearing projected area, sq.in.	15.76	19.7	27.58
Crankpin diameter, inches	2-3/4	2-3/4	2-3/4
Crankpin bearing length, inches	1-25/32	1-25/32	1-25/32
Crankpin bearing projected area, sq.in.	14.7	19.6	29.4
Clutch size, inches	14	15-1/2	17
Weight of basic engine (dry)*, pounds	1160	1350	1635
Fuel consumption, lb./b.hp. hr.	0.45	0.45	0.45
CAPACITIES			
Lubricating oil system, quarts	8-1/2	10-1/2	15-1/2
Fuel oil tank, gallons	30	40	55
Cooling water, gallons	11	12-1/2	15-1/2

*Engine weight includes: Starting motor, governor, oil cooler, oil filter and fuel filter only. Generator, cooling fan, oil bath air cleaner, air intake elbow and engine mountings are not included in the above weights.

Readers' Conference

Engineers' Etiquette

WHILE IN my teens, the chief engineer of the plant took me under his wing and at various sittings instructed me in what he termed "engineers' etiquette".

One time he had met one of the engineers on the street and was so thoroughly disgusted with the man's appearance that he made mental note of it and at the first opportunity gave me a talk.

Said he, "Carl, in the plant, it is often necessary for a man to get besmudged while on a repair job but after this work is finished he should change into clean clothes.

"Because a man is an engineer is poor excuse for grimy hands, rough face and filthy clothes. If you are ever called into the office be sure you are neat and clean as it may spell favor and success to you or—if your appearance is questionable—it may spell failure."

At another time the chief cautioned me about—should I ever be fortunate enough to be in charge of a plant—treating everyone, regardless of the position he held, in the same respect that I would expect. This was kind of a Golden Rule lesson.

It seemed to me that I rarely visited the chief's office but what he passed out a line of fatherly advice and I got so that I actually dreaded to go there. My engineer never gave me any fatherly suggestions and I appreciated it.

Then one day, not from choice but from duty, I was in the chief's office when the 'phone rang. Only a moment before the chief had told me he was so busy he could not call on my engineer that afternoon.

In justice to the chief I will say that it was not an emergency and that the visit could legitimately be postponed.

Under these circumstances it was with distinct surprise that I heard him say, "All right, send him down to my office."

Then he turned to me and remarked, "Here is another bit of engineers' etiquette for you, Carl. A salesman is in the office and wishes to see me. You know that I'm short of any kind of time but this man has come a long way to see me.

"He is on the move from early in the week 'till late and has to take abuse that really belongs to the man who manufacturers the goods this man sells.

"You see the 'ads' in your engineers' magazine and get a faint idea of what it's all about; this man brings the explanation right to your door. Don't turn him away; sometime he'll prove his worth."

It never had occurred to me that the traveling salesman was a much abused person. All of them that I knew smoked mighty good smelling cigars (this was some time previous to the barrage of paper puffs) and took their liquor neat!

But, having learned to be seen and heard at rare intervals, I vouchsafed no reply yet the advice remained deep seated.

Now I'm going to jump a trifle over three decades and show just how that injunction bore fruit.

My plant, carrying a crew of thirty-five men, was closed by depression and it was necessary to cut the working force to six men. Among those indefinitely suspended was my assistant, a man well along in years and financially unable to carry on without work.

For several months he worked on a shift that only, by the best management kept he and his wife from suffering hardship.

One day I was busy on a drawing which I was desirous of completing that afternoon. The telephone rang. A salesman wished to come down to the plant.

It was my intention to tell the operator that positively I could not be bothered; then the old chief's words came to me. Why turn this man down; it would be the first time in my career.

We had been talking but a few minutes when the salesman told me of a plant that wanted to pick up a man just the calibre of my ex-assistant.

Two hours after, a letter was on its way to the above named plant. Two weeks later my ex-assistant was lodged in his new quarters and will be there until age forces him to retire *which will carry a pension.*

Engineers' Etiquette has been broadcasted by me for quite some time and in this one case it was worth all the earaches the old chief ever passed out to me.

New York, N. Y. C. W. PETERS.

Hopper Bottom Cars Over Track Pits

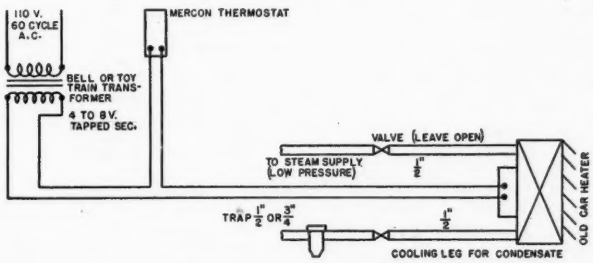
WHERE COAL is received in hopper bottom cars, and discharged from them into a track pit, efficiency depends very largely upon the equipment available and the methods used for doing the work. Considerable danger can be attendant upon this operation. Approved safety wrenches should be provided in all cases for use on these hopper cars, and the car should be accurately spotted in such a position that the operator may have the best of footing. If the trackage is very slightly inclined, and a winch or other device used for spotting the car must pull the car up the slight incline, there will be little danger of its over-running the desired point. Instead, it can be very gently rolled up to the exact spot desired, and will stay there if the winch is held in that position with the cable taut. A winch of the worm gear type will remain right where it is stopped, in addition to being easy to operate.

Especial care should be exercised in cases where coal has been rained on, and slightly frozen afterward, so that it will not feed down out of the car when the hopper bottom is opened. Attempts to prod the coal loose are liable to be very dangerous. For this reason, there are some who prefer to use a very light shot of dynamite for loosening frozen coal. Used judiciously, this will do the job in good shape without any damage whatever to the car. Instructions as to how the explosive should be used for this purpose are of course available from manufacturers of dynamite.

Peoria, Ill. JOHN F. HYLER.

Heating Unit for Small Office

In most power plants the chief engineer's office is a small room that is usually inadequately heated with a cast-iron wall radiator which either overheats the small quarters or is turned off completely to avoid overheating. Automatic temperature control for such small quarters is quite expensive and is therefore omitted. An economical solution to this problem is to install a small unit heater made of an old hot water automobile heater that is often available around a utility that operates a number of cars and trucks.


110 V. 60 CYCLE A.C.
MERCON THERMOSTAT
BELL OR TOY TRAIN TRANSFORMER
4 TO 8 V. TAPPED SEC.
VALVE (LEAVE OPEN)
TO STEAM SUPPLY (LOW PRESSURE)
TRAP 1" OR 3/4"
COOLING LEG FOR CONDENSATE
OLD CAR HEATER

Connections to Heating Unit

The mercury tube type thermostat is quite inexpensive and no motorized valve with the accompanying noisy operation is necessary. Temperature control with close regulation is possible due to the fact that there is no large cast-iron heat storing element involved. This device has been in use here for several seasons and has proved very satisfactory.

Hibbing, Minn. Arthur L. Bennett.

What the Traffic Will Bear

Sometime in the life of every public utility from the village water works to the transcontinental carrier, it is exposed to the accusation that it is "charging all the traffic will hear." The general press seems to be particularly fond of this expression and when an editor receives an electric light bill that is higher than the one issued the previous month when he did not use as much current, he proceeds to write a scathing denunciation of utilities in general. And so the popular impression interprets "charging what the traffic will hear" as a malodorous practice indulged in by companies holding legal monopolies of one form or another, in order to squeeze the last nickel from reluctant, important consumers. Who coined this nefarious phrase is not known, but he should be condemned to the blackest depths of the neologistical hell. For the truth of the matter is that "charging what the traffic will bear", is a very sensible policy, and, if properly applied, works to the advantage of, and not to the detriment of the consumer.

Every commercial enterprise has two types of expenses, fixed expenses and operating expenses. Fixed expenses are those which accrue even if the activity of the business ceases. Taxes must be paid, interest payments on bonds and mortgages must be met. Depreciation will take place, and machinery of all types very frequently becomes obsolete long before it wears out. All these expenses, among others, must be paid whether the plant turns out one nickel lead pencil or a million automobiles. Operating costs, as the name implies, are the costs directly involved in the manufacture of an article, or in the production and distribution of a service. Labor, materials, office supplies and similar items fall into this category.

Now strange as it may seem, electric light and power plants, to take a typical example of a utility, are built primarily to light the home of John Q. Public, to vacuum clean his furniture, to toast his bread, to operate his radio and to perform countless other tasks which we now generally regard as luxuries. Mr. Public merely presses a button and expects results. He cares little when or where he presses that button, he knows little or nothing of the vast complexity of modern machinery which lies behind that button and gives it life; but he does know that his room is dark and that he wants light. Thousands and millions of John Q's duplicates begin to press buttons almost simultaneously as soon as the alarm clock rings, or the sun goes down, and it is only on very rare occasions that the expected service is not forthcoming.

Consequently the utility companies must have sufficient equipment available in order to supply the demand whenever a demand exists. The peak loads come in the morning from about six to nine and in the evenings from sundown to nearly midnight. This leaves the nine daytime hours in which the generator has nothing to do but swap lies with the turbine, while the boiler gently hisses through a mild workout in order to keep fit, "just in case". This idle equipment is eating its fool head off in taxes, interest and so on, so some means must be found to put it to work.

Now suppose there is a laundry near the lighting plant which has a boiler to supply steam for heating and process. The Management is trying to decide whether it will be cheaper to generate the electricity for lighting or to purchase current from the utility. It is found that current can be generated at the rate of three cents a kilowatt-hour. The utility company wants four cents, so the laundry decides to generate its own current.

The utility thereupon makes a few lightning calculations. For each kilowatt-hour generated the operating costs are one and a half cents; the fixed costs are the same. Therefore in order to make a profit each kilowatt-hour must be sold for more than three cents. But it really costs only a cent and a half to generate a kilowatt-hour, the other costs pile up whether the generators roll or not. Then why not sell current for the cent and a half operating costs plus "what the traffic will bear" on the fixed costs? So a contract is drawn up in which the laundry buys electrical energy for two cents a kilowatt-hour, and the utility loses a cent on each unit sold.

If a utility is fool enough to sell its service at a loss, why then should the small consumer pay through the nose? He doesn't pay; he saves. Every unit which the laundry purchases reduces the fixed costs by half a cent. That means half a cent less that Mr. Public must pay. So if a utility could run somewhere in the neighborhood of full capacity during the slack hours, charging what the traffic will bear even though it really loses money, the small consumer would have lower bills in the long run.

This practice is not a custom peculiar to public monopolies. At times it is quite common among competing industries. The ultimate consumer never objects in this case because he can actually see the savings, while the damage that is done is not quite so evident. During the late (we hope) and not to lamented depression, many industries were faced with the prob-

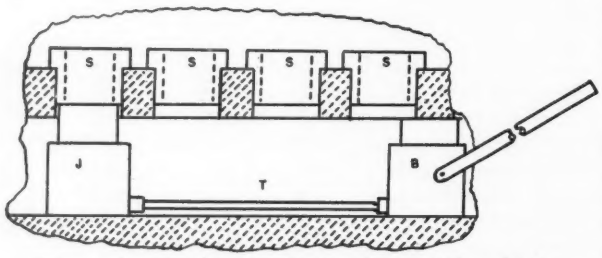
lem of shutting down entirely, or of continuing operations at great loss. Because of the inevitable fixed costs, the loss involved in a complete shut down might be greater than the losses of operation. So operating expenses are cut to the bone and the soap, shoes or sealing wax is sold for the operating costs plus what "the traffic will bear." Thus a fifty dollar coat can be purchased for thirty-five and everyone is happy but the manufacturer. That is, temporarily. No one kicks at being charged "what he can bear" when he saves 30 per cent on a major purchase. But the manufacturer finds that the traffic will bear less and less, and so he continues to cut operating costs. John Q. Public, who is part of those costs, soon finds that fifty dollar coats are being sold for twenty dollars. But Johnnie has only twenty cents. So he blames the local electric light plant for "charging what the traffic will bear."

New York, N. Y. G. CAMPBELL KOHLAR.

Hydraulic Jacks Solve Valve Seat Problem

ALMOST as fast as they could be inserted through the valve cover opening and a load applied on them, the three valve seat pullers furnished by the manufacturer of a set of 7½ by 36 in. triplex plunger pumps sheared off their pivot pins, when an attempt was made to remove the valve seats for renewal after a service life of upwards of 25,000 hr. under a working pressure of 740 lb. per sq. in.

Without considering that the pivot pins might have been selected as a deliberate "weak spot" or safety to break before damage occurred elsewhere in the pullers, the pins were replaced by high carbon, heat-treated pins, and the pullers again put into play. This time failure was delayed while a few of the 288 seats were extracted, and then the pullers broke down, either through stripping of the 1¼ in. thread or through elongation of the shank of the bolt and ultimate section reduction and failure through excessive tension.



Cutaway view of pump valve chamber showing setting of jacks S, S, S,—Valve seats. B—Booster jack. J—Lifting jack. T—Extensible pressure line

Since the pullers were composed of a 1¼ in. bolt, carrying eight threads to the inch, and the wrench used was provided with a six-foot "swamp-stick" extension, the theoretical load on the bolt can be computed, by assuming that the helper applied a force of 100 lb. against the end of the wrench extension, and that that force moved through an arc of one foot at that point. This motion will give an advance or screwing on of the nut along the thread of 0.004144 in. Then, considering the thread as an inclined plane or wedge, the ratio of turning movement to advance is found to be 25.13, plus.

If friction be disregarded, the stress applied is: Turning Ratio times Lever Ratio times Lever Arm Load, or

$$25.13 \times 115.2 \times 100 = 289{,}500 \text{ lb.}$$

It is instantly apparent that this theoretical value exceeds any maximum possible strength in the 1¼ in. bolt; it being as readily understood that this stress is not all transmitted to the bolt in the form of tension, but that much or all of it is absorbed in overcoming friction between nut and whatever surfaces it works against, as internal or thread friction on the one hand, and lower face friction on the other.

Failure of standard types of valve pullers seemed to leave only the plan of setting up a portable boring mill on top of the valve chambers, and boring out to a thin shell each of the many valve seats yet to be pulled. That this expedient would run into much lost time (in possible pumping hours) and would carry a considerable risk of damage to the pump blocks themselves through possible shifting of the boring mill and subsequent cutting of the block itself, caused a search for a possible substitute method.

The problem was solved by using two hydraulic jacks, one provided with a ram which closely fitted within the lower end of the slightly tapered seat bore, the other set up to reach against the solid cross member of the pump casting, and thus permit the hydraulic pressure built up within it to be transmitted through a short section of connecting pipe to the reacting chamber of the jack placed below the valve seat.

The two jacks used, with a nominal rating of 7½ tons by their maker, were the highest rated available for insertion into the constricted passages within the pump, but were worked at virtually twice that rating by the use of a short section of pipe slipped over the handle of the jack used as pump.

Access to the suction and discharge chambers was gained by removing the manifolds connecting thereto, the spotting of the jack used as pump under the end of the casting being made possible by having a set of connecting lines cut and threaded to permit the lifting jack to be centered under any desired valve seat simply by using the appropriate connecting pipe.

Although the theoretical maximum lifting power of the jack combination (doubled, by virtue of the handle extension) could be only 30,000 lb., as against a theoretical strain of 9.6 times that much through the conventional puller and nut, the jacks experienced little trouble in forcing out the most stubborn of the seats, due to the fact that with the revised method all of the power developed save the little lost in ram packing friction was available for forcing free the seats.

During the job of valve seat removal using the two jacks one lot of 48 valves was removed in four hours and 12 minutes elapsed time from the setting of the jack under the first valve to the time when the connecting pipe split under excessive pressure when seat No. 49 resisted even the augmented pressure. The weak spot in the hook-up thus determined, another pipe of the same weight was used as replacement, and the seat jarred with a heavy air-driven riveter during the application of pressure from below.

Following completion of the job, it was estimated that the use of the jacks over the conventional puller

cut the down time by 80 per cent, and likewise saved upwards of 75 per cent of the cost had the boring mill been resorted to after failure of the bolt-and-nut puller.

Long View, Texas — M. T. PATE

Light for the Engine Room

THE ILLUMINATION of the engine room should be adequate to permit reading of all instruments and gages used in the engine room, to permit the engineers to go about their work in a safe manner and to properly illuminate all the floor space, corners and equipment therein. Machine shop intensities are not required in the engine room. If this were true then an intensity equal to 15 foot-candles in the working plane would be installed. In the event that machine shop accuracy may be required in the engine room at times during the overhauling of a machine, an engine, pump or other unit, then sufficient plug receptacles should be installed on columns, along the walls and near the machines to permit the use of extension cords for close and accurate work. It would hardly seem necessary or expedient to bring the engine room light intensity up to 15 foot-candles for general illumination.

We can therefore eliminate the higher intensity of illumination from consideration so far as reasonable practice is concerned. From my observations taken in many power plants the prevailing illumination on the engine room floor is from ½ to 1 foot-candle intensity, as measured by a light meter. This condition is obtained through placing of the lamps in the ceiling above the engine room crane which places them in many instances 30 ft. from the floor. A two-hundred watt lamp looks like a twinkling star at that height and gives just about as much effective light on the floor. Increasing the lamps to 500 watts makes the condition better but poor economy in the use of light prevails.

I do not advocate complete darkness for the upper portion of the engine room, that space up there where the crane must operate. However, a small amount of light will usually suffice. The ceiling lamps may be 150 watt in size placed on 20-ft. centers. To obtain light economically down on the floor and around the engines the elliptical angle reflector located on the side walls is a solution to the problem. These should be placed on 16-ft. centers and be provided with 300 watt lamps being 14 ft. above the floor. If the engine room is wider than 40 ft. then a second row placed about 5 ft. above the bottom row should be used mounting them staggered and dropping the first row down to 10 or 12 ft. above the floor. This will make the top row not over 17 ft. above the floor. Intensity of from 4 to 6 foot-candles are thus obtained which is sufficient for all practical purposes.

A very satisfactory mercury vapor and incandescent lamp installation for engine room use may be obtained by the use of equal values of each type of lamp placed in staggered relation. The mercury lamp alone is not satisfactory due to the stroboscopic effect in viewing rotating machines. This is due to the source of light and the incandescent lamps used with the mercury lamps supply the missing red spectrum and further tends to offset the discontinuous line spectrum of the mercury. An advantage of this type of lamp is that much higher mounting heights may be used with the possibility of eliminating side wall illumination units by their use in some instances. The mercury lamps referred to are of course the high intensity type and not the tube type of mercury lamp.

The writer has used the high intensity mercury lamp in many instances in manufacturing plants and with considerable success. Some of the important operating features of these lamps are as follows: 1. They possess a very low power-factor, 62 per cent, however this can be corrected by the use of condensers bringing the power-factor up to 95 per cent. 2. Reacters are used in series with lamp to stabilize the current. 3. They are 450 watt in size, 230 volt and require transformers when connected to the regular 110 volt lighting circuit. This size lamp compares in number of lumens (14,000), with the 750 watt mazda lamp but consumes only 30 per cent as much current as the Mazda lamp. The comparisons mentioned above with other information is given in the following table using a moderate installation of 40 lamps as the basis.

	Mercury lamp.	Incandescent lamp.
Common voltage	230	115
Size of units in watts	400	750
Number of units	40	40
Watts total	16,000	30,000
Current consumption each, amps.	1.9	6.5
Lamp life, hours of guarantee	1500	1000
Lamp cost	10.62	2.59
Reflector cost with glass-steel diffuser	14.00	14.00
Reactor cost with power-factor correction	15.00	———
Installation including all wiring, conduit and distribution panels	550.00	550.00
Total installed cost	$2134.80	$1213.60
OPERATING AND FIXED CHARGES		
Depreciation 10 per cent	213.48	121.36
Interest and insurance	160.11	91.02
Lamp renewals 1500 hrs. per yr,	424.80	155.40
Power cost at 2c per Kw-hr	480.00	900.00
Total	$1278.39	$1267.78
Unit cost	$53.37	$30.36
Unit operating cost per yr.	$31.98	$31.69

It will be observed from the foregoing that although the initial investment for the high intensity lamp is 75 per cent higher than for plain incandescent lamps the yearly operating cost of the one is only $0.29 per unit higher than the other or less than 1 per cent. Combining the two systems so that there will be 50 per cent of each type of lamp in use would give us a unit cost of $41.87 or a total of $1674.80 for the 40 units.

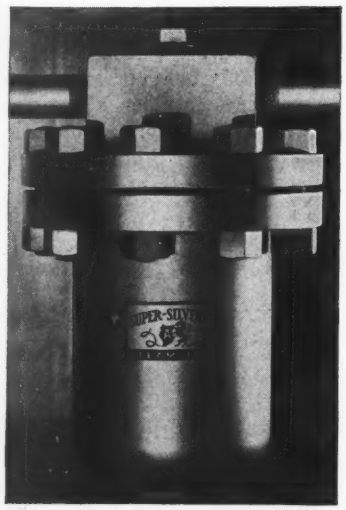
Philadelphia, Pa. — C. C. HERMANN.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Forged Steel Trap

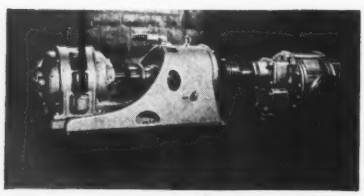
THE NEW trap shown in the accompanying illustration which is a product of the V. D. Anderson Co., incorporates all the features of the regular model Super-Silvertop trap but averages 122 per cent greater condensate capacity than the previous models of Anderson forged steel



traps. These traps are installed straight-in-line, using the inlet connection; or as an elbow, using the inlet connections at the top of the trap. In either installation there are only two threaded joints required, hence only two possible sources of steam leaks. The V. D. Anderson Co., 1935 W. 96th Street, Cleveland, O.

Pumping Unit

A UNIQUE COMPACT pumping unit for bulk transfer service where both thin and highly viscous liquids are handled has been developed by Worthington Pump and Machinery Corp. of Harrison, N. J. The pump is of the herringbone-gear-impeller type driven by a constant-speed motor or



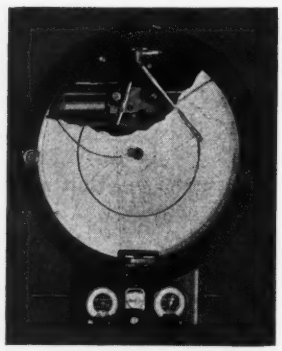
internal combustion engine through a two-speed, enclosed transmission. For light liquids, the pump may be operated at high speed, while for viscous liquids the speed of the pump may be reduced. In either case, the full power of the prime mover is employed.

In conventional applications of single pumping units on such service, motors are selected for the heaviest loads and are operated at a fraction of their rated power when pumping the thinner liquids. The new two-speed unit affords maximum efficiency because a relatively small constant-speed driver is used.

Various applications of these units have proved satisfactory, due to the self-priming high-suction qualities and positive displacement features in the pump. There are no valves to retard the liquid flow, and the entire unit requires little space.

Pneumatic Remote Transmission System

DESIGNED primarily for remote measurement of process variables in atmospheres containing explosive gases, the pneumatic remote transmission of measurement is an entirely new development pioneered by the Brown Instrument Co. div. of Minneapolis Honeywell Regulator Co., Philadelphia, Pa. It consists essentially of a transmitting indicating instrument, at the point of operation and a receiver which may be an indicator or recorder, located at the remote master control board.

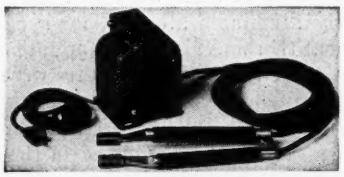


The remote transmission system is simple, balanced air pilot mechanically actuated, built into the indicating transmitter. The receiver is either an indicating or recording pressure gage, calibrated in terms of the variables being measured. An indicator at the point of measurement eliminates guesswork and encourages operators to attain the best possible results.

Midget Electric Pliers

A SMALL SIZE "Thermo-Grip" electric plier unit has been developed to handle small soldering applications in restricted spaces as is often encountered in work inside of switch and fire boxes or in close quarters on switchboards, motors, generators, etc. It is intended for soldering lugs up at 150 amp.

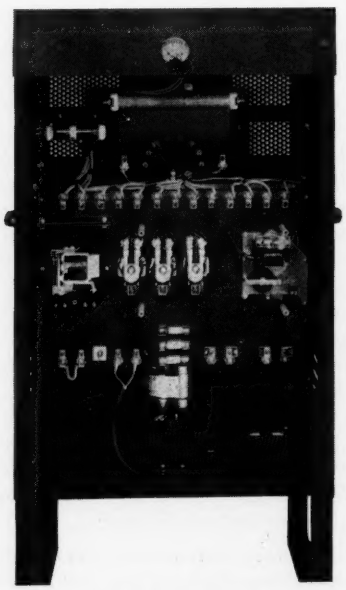
The unit is supplied from a small transformer rated conservatively at 160 watts, continuous duty, or at 300 watts, intermittent duty. The secondary winding of this transformer is completely insulated from the primary, making it possible, in emer-



gencies, to work on soldering applications on wires at potentials ordinarily maintained on wiring circuits. Ideal Commutator Dresser Co., 1033 Park Ave., Sycamore, Ill.

Automatic Battery Charger

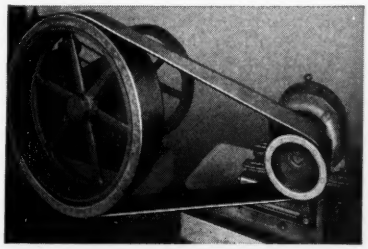
FOR CHARGING BATTERIES of smaller sizes, such as for control bus, switch operation, emergency lighting and the like, this unit provides automatic charging. It is of copper oxide rectifier type, relay controlled and fan cooled. A synchronous time switch puts the battery on charge at definite intervals, usually once an hour and when charging is complete, it is automatically discontinued. In case of emergency discharge, charging will be continued, even over a period of several hours until recharge is completed.



The charger is primarily designed for use with 60 cell batteries of 80 to 240 amp.-hr. capacity on an 8-hr. basis. It continues charging uhtil voltage rises to 2.33 v. per cell at 70 deg. F., by its on and off action keeping the battery fully charged at all times. It is made by Electric Storage Battery Co., Philadelphia, Pa.

Fibre Pulley Lagging

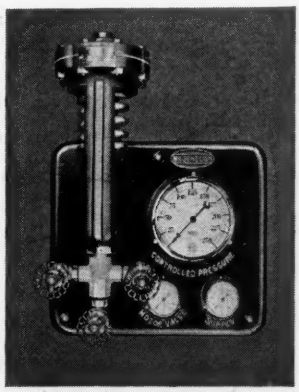
To INCREASE pulley diameter when increased belt speed is desired and to get better grip of the belt on the pulley, fibre laggings of the same material as used for



paper pulleys have been designed and are available in any width and for diameters up to 72 in. They are held to the pulley run by a special clamp. They are the product of Rockwood Mfg. Co., Indianapolis, Ind.

New Pressure Controller

THE SYNCROMASTER PRESSURE CONTROLLER announced by Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass., is a simplified hydraulic operated combination of pilot mechanism and a diaphragm actuated control valve of the latest design. The unit was developed to improve control and to reduce installation and maintenance costs. Very stable and accurate control is obtained because of the full throttling features of pilot and control valves. Operation is hydraulic, using any external supply of 20 to 150 lbs. pressure.

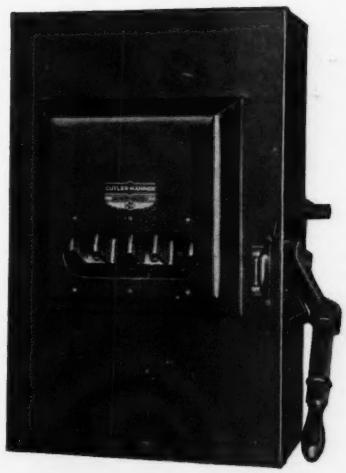


The controlled pressure, balanced by the setting of the springs, is piped to the pilot valve diaphragm. Increases or decreases in this pressure move the piston valve to increase or decrease the control valve diaphragm pressure positioning the valve plug to maintain the required pressure in the system. In operation the control valve plug is in a "floating" position, moving only sufficiently to maintain the required flow of the controlled medium.

Pilot construction features include self-alining spring buttons, thrust ball bearing of stainless steel, stainless steel ball bearing guides, lap-type piston valve of 18-8 stainless steel and multiple springs. The pilot may be mounted on wall or panel or directly on the control valve. Control valve features include ball bearing guides; use of 18-8 stainless steel for all parts subject to friction and corrosion; streamlined parabolic centroguide valve plugs; pressure lubricator. Either normally open or normally closed valves may be used.

Window Type Current Breaker

THIS NEW safety switch has a window in the cover for inspection of the blades, the glass being $\frac{3}{16}$-in., shatterproof, held securely against sponge rubber gasket. The



switch has quick-make-and-break double contacts with silver plated blades and jaws. It is made in sizes 30 to 1200 amp. for voltages up to 600 by Cutler-Hammer, Inc., Milwaukee, Wis.

Cosmetics for Workers

A NEW TYPE of protective treatment for the hands of industrial workers is being marketed by the Davis Emergency Equipment Co., 55 Vandam St., New York. The treatment consists in the use of two different creams (known as No. 1 and No. 2 Eco Protective Creams—Davis) one for protecting the hands during work and the other for use after work.

The No. 1 cream is rubbed into the hands, and on the arms, if necessary, before starting work. It forms an invisible, non-sticky, unnoticeable film which protects the skin from the action of chemicals, solvents, grease, oil, gasoline, and other substances harmful to the skin. When the hands are washed at noontime and night, the film comes off easily, bringing with it all the dirt, grease, paint, lacquer, etc., that the hands have picked up, and leaving them smooth and clean without the use of abrasives.

The No. 2 cream is applied after finishing work for the day. It replaces the natural oils of the skin with a soothing cream which keeps the hands soft and free from chapping and cracking. This cream is also used by those whose hands are constantly wet with water, since the No. 1 cream is not suited to provide protection against the effects of water and aqueous solutions.

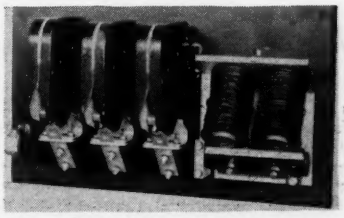
Steam-Jet Ejectors

WORTHINGTON PUMP AND MACHINERY CORP. of Harrison, N. J., announces their improved single stage steam jet ejectors. Uninterrupted service at higher overall efficiencies is assured by the new design of this machine, which incorporates an internal steam strainer in the nozzle head.

Other claims made for this unit include low suction entrance losses, due to the streamline design of the suction passages; low initial cost and maintenance; extreme simplicity; minimum weight; small space requirements; no moving parts; and no lubrication required.

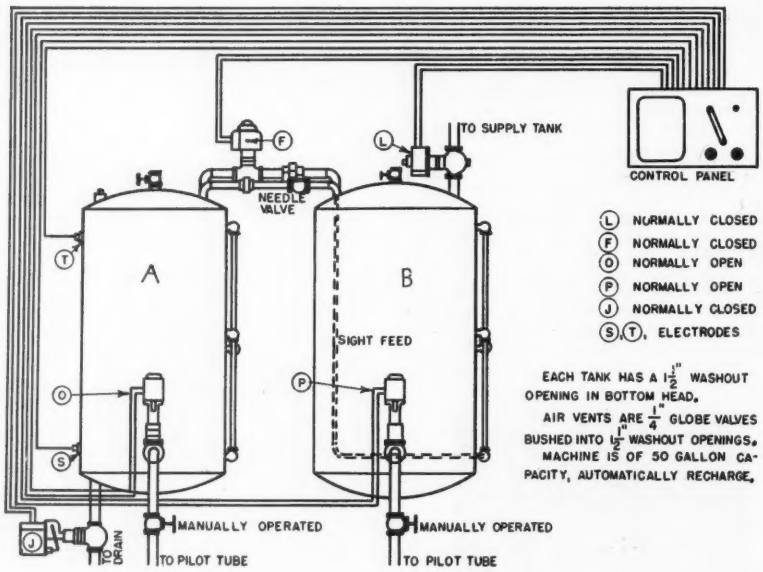
Humless Contactor

FOR USE where noise reduction is important, General Electric has announced a new line of d-c operated a-c contactors which will not hum during operation. The new devices were developed as a result of a growing demand from hotels, hospitals, and schools for equipment of this type. They are also entirely suitable for use in office buildings, theaters, auditoriums, central-stations, substations, stores, ocean liners, show rooms, large private residences, and similar places where magnetic hum is objectionable.



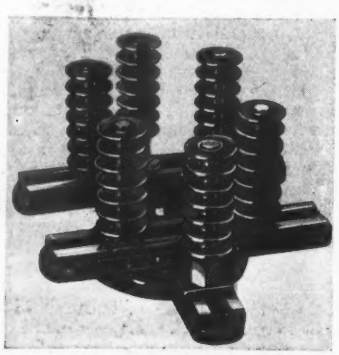
The contactors have the following salient features: only a small amount of power is required to hold the circuit closed; they are unaffected by normal voltage variations; they are inexpensive and relatively simple in construction; their current-carrying parts are conservatively rated on an eight-hour basis at 600 v.; and they can be used on either a-c, through rectifiers, or directly on d-c where available.

FOR A 100 HP. motor drive from 17½-in. to 60-in. pulleys on 14 ft. 4 in. centers at 1800 r.p.m., a Goodrich Highflex belt, 20 in. wide, after 16 mo. service has had the take up moved only 2 in.



Winding Head for Small Coils

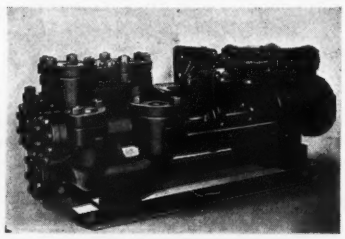
A NEW Midget Coil Winding Head, recently introduced by the Ideal Commutator Dresser Co., designed for making coils 1¾ in. by 4 in. minimum up to 8½ in. by 6 in. maximum, can also be mounted and used on the face plate of any lathe having a 12 in. swing or larger, or on any other turning devices.



The unit consists of a machined base for mounting on the face plate of a lathe or coil winder drive, with two cross arms to insure rapid and accurate setting. There are six spaces on the spindles for coils. The open construction allows the operator to wind all six coils in series, thereby eliminating the necessity of soldering and taping joints, and gives him only two ends to join. Ideal Commutator Dresser Co., 1033 Park Ave., Sycamore, Ill.

Duplex Steam Pump

A NEW duplex steam pump with an eight-cover side-pot type fluid end and an improved piston valve steam end has been announced by Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. This new steam pump, developed particularly for industrial and oil field boiler feed service, but well suited to many general industrial applications, offers an economical means of handling oil, water or other free-flowing liquids at high pressures and in large quantities. Sizes are available for capacities up to 148 g.p.m. and fluid-end pressures up to 1000 lb. per sq. in. The balanced, piston-type steam valves assure efficient operation even with high steam pressures and with super-heated steam. The eight-cover side-pot fluid end permits easier servicing.



Steam and fluid ends are sealed by an ample supply of packing in an extra deep stuffing box fitted with a removable bolted gland. The cradle between the steam and fluid ends is long enough to permit access to both stuffing boxes. No part of the piston rod enters both stuffing boxes.

Explosion-Proof Squirrel-Cage Motors

THE RELIANCE ELECTRIC & ENGINEERING CO., 1088 Ivanhoe Road, Cleveland, Ohio, announces a line of explosion-proof squirrel-cage alternating-current motors (Type AA), with mounting dimensions conforming to N.E.M.A. standards. These motors have been tested and approved by The Underwriters' Laboratories for Class 1 Group D hazardous locations which include those in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are made, used or stored in other than the original containers. The construction is such that all working parts are completely enclosed, and the housing is strong enough to withstand even an internal explosion without bursting, loosening the joints, or permitting flame to escape into the outside air. Rotors are integrally cast to assure reliability and uniformity of performance.

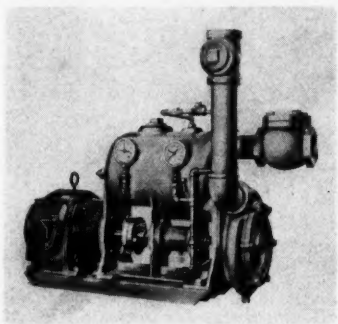
Automatic Chemical Proportioner

D. W. HAERING & CO., INC., 3408 Monroe Street, Chicago, Ill., announces development of a new automatic proportioning unit designed for the continuous introduction of chemical solutions without attention to recharging requirements. The model "WW" Feeder is a standard type Model "B" Feeder constructed with an automatic recharge arrangement- to cut down the size requirements. It proportions accurately, provides sight feed indication, prevents needle valve clogging and recharges itself whenever necessary. The new feeder is shown in the illustration. Valves L, F, O, P and J are solenoid operated. Electrodes S and T are installed in compartment A or the oil compartment. Red oil has a high dielectric constant and is an extremely poor conductor whereas even the purest natural water has an appreciable electrical conductivity. This fact is the basis of control. The electrodes and valves are connected to a control box containing the necessary control relays.

The unit is installed according to the usual procedure and compartment A is filled with Red Oil and compartment B with the chemical solution. The control switch is thrown to the "on" position and the manually operated pitot tube valves are opened. The machine is now under line pressure and begins to proportion. As the unit operates, water rises in the oil compartment and completes the circuit through the electrode at the bottom of the compartment. No current flows through the control panel. Water continues to rise in the compartment until it reaches the top electrode when the relays in the control cabinet operate to energize the solenoid valves. Valves O and P close while valves J, F and L open permitting the machine to recharge.

New Self Priming Pump

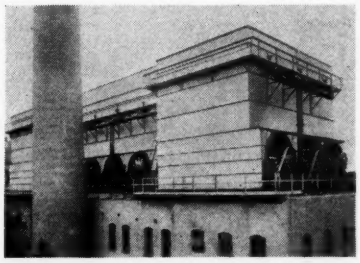
THE HAZLETON-AUTO-PUMP combines in a compact unit a high grade pump and a priming tank, adaptable to automatic control. Only part of the air handled during the priming period passes through the pump. The greater part is expelled from the priming tank directly into the discharge line. The priming tank retains sufficient water to prime a short suction



line. Repeated starts are necessary to prime long lines, the number of starts depending on the length of the line and the suction lift. A high vacuum can be obtained. Once primed, the pump will hold its prime for days, because it is under pressure when standing idle, and air cannot leak into the casing through the stuffing box. The priming cycle can be controlled manually or automatically. Barrett, Haentjens & Co., Hazleton, Pa.

Forced Draft Cooling Tower

ONE OF THE largest forced draft cooling towers ever installed on a brewery has just been completed for the Jacob Ruppert Brewery, New York, N. Y., by The Cooling Tower Co., 15 John Street, New York, N. Y.



The cooling tower is 44 ft. wide by 134 ft. long and 36 ft. high. It has an all-steel frame with Balke type California redwood filling. The tower is divided into eleven separate cells and air is supplied by eleven 10-ft. Jeffrey fans with aluminum blades, driven by 20-hp. Westinghouse motors. The tower cools 13,000 gal. of water per minute used for condensing steam and for cooling ammonia condensing water for refrigeration.

Welding Pre-heater

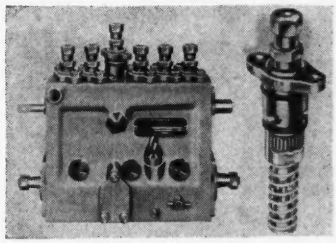
DEVELOPMENT of a rapid and flexible electric pre-heater for use on alloy pipes before welding is announced by Detroit Electric Furnace Co. of Detroit, Mich. Advantages claimed for the equipment are its speed of installation, simplicity of operation, low maintenance cost, accurate temperature measurement and the fact that it can be used to pre-heat pipes before welding and during the welding operation without manual adjustment of the heating elements. Any temperature up to 600 deg. F. can be maintained during the welding operation.

The equipment consists of an indicating pyrometer, two-heat switch and an arrangement of adjustable heating elements in a connecting linkage which holds the heating elements in direct contact with the pipe. As a result a temperature of 600 deg. F. is reached in less than three-quarters of an hour on a six-inch carbon-moly pipe. Similar heating-up rates are possible on larger pipe sizes. The complete equipment is supplied in a special shipping container and includes two-heat switch, extra heating elements, insulating blankets, pyrometer and jumper cable. The equipment is designed for operation on any 220-v. power line, single phase. Heaters are arranged for heating a distance of approximately four inches on either side of the weld to a temperature determined by the operator.

The Detroit Pipe Preheater has been designed as a supplement to the induction stress reliever which the Company makes for use on high-temperature, high-pressure welded joints. The apparatus is of course flameless, and being of low mass, it is rapid in its action, according to the makers. It requires less than 30 kw. for operation and is designed in two sizes, one for pipe sizes up to a maximum of 14 in. pipe, and a second to handle up to 24 in. pipe.

Units for Fuel Injection Pumps

RENEWABLE PUMPING UNITS having a plunger diameter range from 4 mm. to 9 mm., for use in Timken fuel injection pumps are the latest advance in this fuel injection equipment and simplify servicing in the field. The unit, which is self-contained, accurately metered and precisely timed mechanism, comprises in a rigid, simple unit body the barrel and plunger, the delivery valve and the delivery valve spring. It is held in the injection pump housing by nuts on two studs in the pump housing bearing on the flanged upper end of the pumping unit body. The unit is positively alined axially in the housing by close



fit in the housing bore and by one of the flange holes being accurately slotted to bear tightly on two sides of one of the dowel studs, so that the unit must be correctly alined to be inserted. The flange seats on a gasket against the flat top of the housing.

To ensure calibration of one unit in relation to the other pumping units, means are provided so that the unit can be slipped into the housing only when it is so set that the pinion gear on the upper metering sleeve will properly index the correct teeth in the control rack-rod of the injection pump. A protruding nib extending form a flat surface must be in line with a second flat surface on the unit body and a double tooth space in the control rack-rod before the unit can be either pulled out of the housing or slipped in so that it is impossible to replace a unit incorrectly. By this means a unit can be quickly replaced, pump rebuilding is avoided and spare units may be kept on hand at all times. The Timken Roller Bearing Co., Canton Ohio.

Heavy-Duty Push Button

A NEW line of heavy-duty control stations, of the surface and flush mounting types, has just been developed by the Allen-Bradley Co., 1311 South First St., Milwaukee, Wis., to supplant their existing line of heavy-duty stations. These units have a maximum d-c rating of 2.5 amp., 115 v.; 1.25 amp., 230 v.; 0.25 amp., 550 v. Maximum a-c rating: 10 amp., 110-220-440-550 v.

The push button mechanism is of the unit type construction and can be mounted in combinations of one to ten buttons. These units have a set of normally open and a set of normally closed double break, silver alloy contacts. Two-way and three-way selector switches and pilot lights utilize the same base and are interchangeable with the push buttons.

Bulletin 800 surface mounting stations have an attractive modernistic, black enameled, pressed steel enclosing box, with multiple knockouts on top and bottom. Removing the front cover exposes both front and sides, permitting easy wiring and inspection.

Samuel Moore

SAMUEL MOORE, for many years general superintendent of the Service and Erecting Division of Allis-Chalmers Mfg. Co., died suddenly in Milwaukee on December 14th at the age of 72. Although born in New York City he spent his early manhood working for copper mining companies in Northern Michigan. In 1891 he joined the E. P. Allis Co. as machinist and soon thereafter went on the road erecting many of the big steam engines built in those days for electric railway and lighting plants both in this country, and abroad, including supervision of the installation for the famous London two pence underground tramway. On his return to this country in 1903 he was placed in charge of Allis-Chalmers Eastern District Erecting Division with headquarters in New York. In 1911 he was appointed as the company's first general superintendent of Erecting and Service with headquarters at the West Allis Works. In this capacity he built up a large and efficient organization for erecting and servicing Allis-Chalmers power, electrical and industrial machinery anywhere in the world. In addition to this responsibility Mr. Moore put in much time and effort in developing many of the welfare and other related activities of the company. He was unselfish and retiring in nature with a manly regard for his fellowmen. Throughout his long career he enjoyed a wide acquaintance not only in his own growing organization but throughout industry in general.

Five New Fellowships at Westinghouse

FIVE POST-DOCTORATE fellowships for reserch in modern physics at the Westinghouse Research Laboratories in East Pittsburgh during 1938-39 will be awarded this spring to young scientific workers, according to an announcement made today by the Westinghouse Electric and Mfg. Co. Appointments will be for one year and the fellows will be eligible for one reappointment. Five more fellows will be appointed the following year under a plan which provides ultimately an opportunity for ten physicists to continue their researches using the facilities of one of the nation's leading industrial laboratories.

A circular giving details of the plan was mailed December 14, 1937, to universities and technical schools, inviting applications for fellowships from men of academic training equivalent to the doctor's degree in physics, chemical physics or physical metallurgy. Applications must be received by March 1, 1938, and awards will be announced early in April, 1938. Candidates are expected to propose a definite research problem within the field of the Laboratories' activities on which they plan to work. The work of the fellows will be under the general supervision of Dr. E. U. Condon, formerly of Princeton University, and recently appointed associate director of the Laboratories for the program of fundamental research.

It is not necessary that the proposed research be one for the results of which a technological use is evident, according to the official announcement. The Company feels that all research leading to a better understanding of the nature and energy will ultimately prove valuable to technology even though its immediate field of application is not apparent.

In the interest of efficiency it is desired to confine the fields of work to those for which the Laboratories are well equipped. Owing to the breadth of interests represented this is, however, not a serious limitation. Problems in the fields of nuclear physics, electric conduction in gases, ferromagnetism, dielectrics, thermionics, semi-conductors, elastic and plastic properties of metals, crystal structure, are appropriate. Applications outside these general fields will also be given consideration.

It is expected that two or three of the fellowships will be available for research in nuclear physics on a program which uses the Laboratories' new electrostatic generator to study the laws governing atomic transmutations, artificial radio-activity, and the forces which hold atomic nuclei together. Other fellows will probably work on studies of the fundamental properties of metals, of magnetic materials, of insulating materials, of the processes governing the flow of electricity in gases and other problems of fundamental physics.

Joseph S. Hammerslough

JOSEPH S. HAMMERSLOUGH died in Tucson, Ariz., on December 10 following long illness with asthma, complicated with a heart ailment. He was 64 years old and had been active in business and civic affairs in Springfield, Ill., during his entire career having been born in Springfield in 1873 and progressed step by step from menial work as a youth to the position

Joseph S. Hammerslough

of vice president of the Springfield Boiler Co. His formal educational preparation was secured in the public schools followed by a business college course with which background he secured employment in a furniture factory, but at 17 years of age took a position as office boy with the Springfield Boiler Co. His advancement from that position was ever upward through the minor executive positions to sales manager, general manager and vice president. His work for the company took him to all parts of the United States and Europe.

Civic affairs were of extreme interest to Mr. Hammerslough and he held offices for many years in the Springfield Chamber of Commerce, serving as president in 1933. He was also an active member of the Rotary Club, the Elks Club, the Standard Club, the Sangamo Club and past president of the Brith Sholom Temple.

New Officers for General Electric

CHARLES E. WILSON of Bridgeport, Conn., has been elected executive vice-president of General Electric Co., as announced by President Gerard Swope. Mr. Wilson has been with the company since 1899, starting as office boy with Sprague Electric Co. and progressing through the

Chas. E. Wilson

factory to superintendent. Following acquisition of Sprague by General Electric, he went to Mazpeth and New Kensington works as assistant general superintendent and later to Bridgeport. Since 1928, Mr. Wilson has been in the appliance merchandising department and in charge of such activities since 1935. He has been a vice-president of General

Philip D. Reed

Electric Co. since 1930 and is now promoted to the newly-created position of executive vice-president.

Philip D. Reed, who entered the employ of the General Electric Co. in 1926 and has been general counsel of the lamp department since 1934, becomes assistant to the president. He is a graduate of Univ. of Wisconsin in electrical engineering and of Fordham as doctor of laws.

News from the Field

CUTLER-HAMMER, INC., of Milwaukee, Wisconsin, as part of its foreign trade activities announces that a company known as Canadian Cutler-Hammer Limited has been organized for the purpose of manufacturing its products for the Canadian market. The company, whose headquarters address will be 384 Pape Avenue, Toronto 6, Canada, will be a subsidiary of the Amalgamated Electric Corp. Limited, which will provide the manufacturing facilities. Northern Electric Co. of Canada will act as the distributor for the new Canadian company.

POWER ENGINEERS from southern states including Florida, Georgia, North Carolina, South Carolina and Tennessee will meet in Atlanta Feb. 8 for an all-day fuel engineering conference sponsored by Appalachian Coals, Inc., Cincinnati, O. Coal retailers will meet in the evening to study merchandising stokers and stoker coals.

Papers to be presented will include: Fuels of Today and Tomorrow by Dr. A. C. Fieldner, Washington, D. C.; The Nation's Power Supply: Its Economic Development Under Private Enterprise, by Frank F. Fowle, Chicago, Ill., past president, Western Society of Engineers; Selection of Pulverized Coal Equipment, by Ollison Craig, Riley Stoker Corp., Worcester, Mass.; The Multiple Retort Stoker, Its Modernization and Application of Water Cooling, by C. W. Baldwin, American Engineering Co., Philadelphia, Pa.; The Spreader Stoker, by M. H. Snodgrass, Detroit Stoker Co., Detroit, Mich.

At the evening meeting on retailing of bituminous coals, the papers will be: Modern Retail Coal Merchandising, by R. E. Howe, president, Appalachian Coals, Inc.; Small Industrial and Residential Stokers, by T. A. Marsh, The Iron Fireman Manufacturing Co., Chicago; Automatic Residential Heating with Bituminous Coal, by R. A. Sherman, Battelle Memorial Institute, Columbus, O.

To date Appalachian Coals, Inc., has sponsored 21 fuel engineering conferences since 1934, 19 in Cincinnati, one in Detroit and one in Kalamazoo, Mich.

GRAVER TANK & MFG. CO., INC., now entering its 74th year in business, has enlarged its manufacturing facilities by the addition of several new, modern buildings with latest equipment at its Catasaqua, Pa., plant, for the manufacture of tanks for every purpose, steel plate construction work and water treating equipment.

ANNOUNCEMENT was recently made of the appointment of Joseph A. Messenger, formerly of United Engineers & Constructors, Inc., as general manager of the Buell Engineering Co., Inc. Mr. Messenger became associated with the construction department of the United Gas Improvement Co. in 1910. He supervised the construction of gas apparatus, both coal and water gas; power plants and gas distribution systems. He became assistant to the vice-president in charge of engineering of the U.G.I. Contracting Co. and when United Engineers & Constructors, Inc. was formed, he was placed in charge of the pipe line construction department, which post he held until his recent appointment. Mr. Messenger will now be located at the headquarters of Buell Engineering Co., 70 Pine Street, New York, N. Y.

ORDERS RECEIVED by General Electric Co. in the fourth quarter of 1937 amounted to $73,997,063, compared with $84,857,181 in the same period of 1936, a decrease of almost 13 per cent, President Gerard Swope announced on January 10. For nine months, the total was $305,276,556, compared with $211,891,038 for nine months of 1936, an increase of 44 per cent, making total orders for the year $379,273,619, compared with $296,748,219 last year, an increase of 28 per cent. Sales billed and earnings for the year 1937 are not yet available, but will be given in the annual report to be issued in the latter part of March.

NORTON CO., Worcester, Mass., announces the appointment of Robert M. Onan as salesman for the Refractories section of the Abrasive Division. He will make his headquarters in the Norton Chicago office and will cover Illinois, Wisconsin, upper Michigan, Indiana and Missouri. Mr. Onan has had nearly twenty years' experience in refractories work, most of it in the Chicago district.

INDUSTRIAL Sales and Engineering Co., 501 Citizens State Bank Bldg., Houston, Tex., of which J. H. Drapier and W. R. Davis are partners, has been appointed sales agent for Laminated Shim Co., Inc., Long Island City, N. Y., for Texas, Oklahoma, Louisiana and southern Kansas. Branch offices will be maintained in Dallas, Tex., and Tulsa, Okla.

E. S. MARLOW of 1238 Marquette Drive, Detroit, has been elected Secretary-treasurer of Michigan Coal & Coke Salesmen's Club. Mr. Marlow is special representative of Appalachian Coals, Inc., for Michigan, Ohio and Indiana.

MARVIN G. KIRN, Huntington, W. Va., has been added to the staff of Island Creek Coal Sales Co., agent for one of the producing units of Appalachian Coals, Inc. A graduate of Case School of Applied Science, Mr. Kirn has had 15 yr. experience in coal sales with M. A. Hanna Co. and Coral Coal & Coke Co.

The Island Creek Co. has also appointed U. B. Yeager, a graduate of Purdue University, with fuel engineering experience with Peoples Gas Light & Coke Co., Chicago, Koppers Research Corp., Pittsburgh, Carnegie-Illinois Steel Corp., Gary, and other large concerns, as combustion engineer.

PAUL BATTEY and Leonard C. Childs have become associated at Battey & Childs for consulting work on industrial plants, railroad shops and power plants with offices at 231 So. La Salle St., Chicago, Ill.

ROBERT W. HUNT CO., which was organized in 1888 by Captain Robert W. Hunt and associates is celebrating its golden anniversary. Its field has been inspection of steel and other building materials for railroads, buildings, power plants and the government. Present officers are, J. C. Ogden, president, F. M. Randlett, vice-president and general manager, D. W. McNaugher, vice-president and treasurer, W. A. Gresens, secretary.

WHEELCO INSTRUMENTS CO., 1933 South Halsted St., Chicago, Ill., has recently appointed three new representatives to handle the sales and service of Wheelco temperature control, indicating, and safety instruments in their respective areas, as follows: C. I. Gillen 5026 Osage Ave., Philadelphia, Pa., H. F. Rehling 993 South St., Boston, Mass., and R. W. Coward 2400 Arlington Ave., S., Birmingham, Ala.

PITTSBURGH PIPING & EQUIPMENT CO., Pittsburgh, Pa., announces the appointment of Garrett Burgess, Inc., Woodbrook Bldg., Detroit, Mich., as district representative to represent both the Piping Division, that fabricates and erects power and process piping systems, and the Alloy Division, that specializes in the fabrication of stainless steel piping tanks and vessels.

SOUTHERN INDIANA GAS & ELECTRIC CO., Evansville, Ind., announces a 1938 construction program totalling $2,500,000, including enlargement of the generating plant, installation of 20,000-kw. generator, building of several new substations, and extension of rural lines.

CHURCHILL RIVER POWER CO. plans the installation of a 19,000 hp. unit of its Island Falls, Sask., hydro-electric plant at an estimated cost of $600,000. The equipment is to be placed into operation in 1939.

KEASBEY & MATTISON CO., Ambler, Pa., manufacturer of asbestos-cement building products and asbestos-magnesia insulations, announces the inclusion of a full line of asphalt products; shingles, roll roofing, sheathing papers, liquid coating, fibre roof coating and solid roofing asphalt. Distribution of the new line through Keasbey & Mattison Company's nation wide outlets is now in process of arrangement and the materials will shortly be available to contractors everywhere.

YORK ICE MACHINERY CORP. held a conference of its distributors and an exposition of new products for air conditioning and refrigeration at York, Pa., Jan. 11 to 13.

WISCONSIN MICHIGAN POWER CO. has been authorized to purchase the hydro-electric plant and transmission system of Northern Paper Mills, by edict of Federal Power Commission and with approval of regulating bodies of Wisconsin and Michigan. The property includes Chalk Hill and White Rapids plants on the Menominee River, transmission lines between the two plants and to Amberg and Green Bay, Wis. Capacity is 15,800 kw.

NATIONAL AND REGIONAL meetings of the Society of Automotive Engineers have been announced as follows: National Aeronautic meeting, Mayflower Hotel, Washington, D. C., March 10 and 11; National Passenger Car meeting, Hotel Statler, Detroit, Mich., March 28 to 30; Summer meeting at The Greenbrier, White Sulphur Springs, W. Va., June 12 to 17. The first annual meeting of the year was held January 10 to 14 at Book-Cadillac Hotel, Detroit, Mich.

A. O. SMITH CORP. of Milwaukee, Wis., announces the opening of a district office in the Gulf Building, 439 Seventh Avenue, Pittsburgh, Pa., in charge of R. L. Howes. After graduating from Iowa State College in 1911, Mr. Howes was with the Peoples Gas Light & Coke Co. of Chicago, the Studebaker Corp. at Detroit, and then many years with Fairbanks, Morse & Co. in the southwest, and later in the executive offices at Chicago. During the past 3 yr. he was eastern manager of Diesel Engine sales for the Worthington Pump and Machinery Corp.

WITH DEEP REGRET Norberg Mfg. Co., Milwaukee, Wis., announces the death of Mr. Rudolf Wintzer, who for more than twenty-five years has been associated with this company.

In 1924, Mr. Wintzer was appointed to the position of Chief Engineer, continuing in that capacity until 1935 when, desirous of being relieved of the more strenuous duties of that office, he was succeeded by his assistant, Mr. Emil Grieshaber, as Chief Engineer. From 1935, until his death, Mr. Wintzer held the office of Consulting Engineer and served in an advisory capacity on engineering problems.

GOVERNOR HARRY W. NICE, a 207-ft. Diesel powered ferryboat with capacity for 750 passengers and 65 automobiles and trucks, built by The Maryland Drydock Co., a Koppers subsidiary, for service between Annapolis and Matapeak, Md., was launched Dec. 11. The ferry has a double ended type steel hull, propelled by a single main engine driving a propeller at each end on a through shaft. The power plant will consist of one Fairbanks-Morse, eight cylinder, 16 in. bore by 20 in. stroke, main Diesel engine, developing 1400 b.hp. at 300 r.p.m., and two Fairbanks-Morse 50 kw., 120 v., direct current, Diesel generators. There is to be one Diesel-driven emergency air compressor and one motor driven air compressor. All pumps will be motor driven. Fresh water is used for jacket cooling. An oil-fired boiler will furnish steam for heating by means of radiators and fan heaters. Fuel oil is carried in two 3500 gal. double bottom tanks.

DR. EDWARD R. WEIDLEIN, director of Mellon Institute, Pittsburgh, has announced the establishment of an industrial fellowship by the Westinghouse Electric and Mfg. Co. for the study of problems in the field of dielectrics and electrical insulation. Dr. Robert N. Wenzel, a member of the Mellon Institute research staff since 1927, has been appointed fellow in charge of this project.

The dielectrics fellowship has as its general objective the development of improved insulating materials and processes for application to equipment of Westinghouse manufacture, and it brings the facilities of Mellon Institute into cooperation with those of the Westinghouse Research Laboratories at East Pittsburgh in insulation research.

M. H. RHODES, INC., has moved its executive and general sales offices from Rockefeller Center to its factory at 30 Bartholomew Ave., Hartford, Conn.

ELGIN SOFTENER CORP., Elgin, Ill., recently announced the appointment of John S. Hayes as district representative in northwestern Ohio, with offices at 1508 River Road, Maumee, Ohio.

FOLLOWING the resignation of Ernest Wooler, Chief Engineer of The Timken Roller Bearing Co., A. L. Bergstrom has been appointed Executive Engineer to coordinate some of the varied engineering activities of the company. A graduate of the Royal Technical Institute of Sweden, Mr. Bergstrom spent several years with the Krupp organization in Germany. After a number of years in design work in this country, he became connected with The Timken Roller Bearing Co. in 1929 in the Works Engineering Department, advancing to the position of Chief Works Engineer, which position he filled until his appointment as Executive Engineer of the company.

OWEN MCSHANE, recently chief engineer of the Ohio Farmers' Cooperative Milk Association and formerly smoke inspector for the city of Cleveland, Ohio, died recently at his home in Cleveland after an illness of several weeks. Mr. McShane came to Cleveland in 1908 direct from Ireland, where he was born sixty years ago, and entered the employ of Swift & Co. He advanced from master mechanic to chief engineer then, in 1926, he entered the city smoke inspection department which position he left in 1930 to become chief engineer of the milk association. Surviving him in his family are his widow, three daughters and a son.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO. announces the appointment of Dr. E. U. Condon, former associate professor of physics at Princeton University, as associate director of research at its laboratories in East Pittsburgh, Pa. Working under Dr. Condon will be ten research fellows who will explore fields of pure science, including nuclear physics, electric conduction in gases, ferro-magnetism, dielectrics, thermionics, semi-conductors, elastic and plastic properties of metal and crystal structure.

J. R. A. HOBSON, JR., has been appointed project engineer for the public works administration for the $5,766,750 municipal hydro-electric plant being planned by High Point, N. C., on the Yadkin River.

ENGINEERING PUBLIC SERVICE COMPANY, New York, announces the election of Donald C. Barnes, formerly central district manager for the Puget Sound Power & Light Co., Seattle, Wash., as president, succeeding Samuel B. Tuell, who will continue as vice president and controller. R. N. Benjamin was elected secretary, to succeed William T. Crawford, who is devoting all his time to engineering and management affairs of Stone & Webster, of which he is executive vice president. These changes were coincident with the move of Stone & Webster to relinquish control of the service company in conformity with the Public Utility Holding Company Act.

HORACE CARY, Kearney, Nebr., has been elected president of the board of the Platte Valley Public Power and Irrigation District. He succeeds Harry L. Williams, Gothenburg, Nebr., who resigned.

C. K. WEST, commercial vice president of General Electric Co., has been reelected president of the Electrical Association of Philadelphia for the fourth consecutive year.

W. F. COCHRANE, former South Dakota state PWA director, has been appointed manager of Watertown, S. D., light and waterworks utilities.

ZED E. MERRILL, Albany, Ore., has been elected president of the Mountain States Power Co., succeeding C. M. Brewer, Medford.

ELECTRIC RAILWAY EQUIPMENT SECURITIES CORP., New York, announces the election of H. L. Andrews, vice president of General Electric Co., and L. W. Lyons, treasurer of Westinghouse Electric & Manufacturing Co., to its board of directors.

ARKANSAS POWER & LIGHT CO. announces the appointment of Albert West as manager of the electric utility at Batesville, Ark., to succeed E. H. Glenn, manager since 1924, who resigned because of ill health.

ROBERT S. BROWN, advertising executive and a prominent figure in the railway supply field, died suddenly last night at his home in Rutherford, N. J. Mr. Brown was vice president and treasurer of the G. M. Basford Co., advertising agents, with whom he had been connected since 1916. He was 51 years of age.

Mr. Brown was a graduate of Pratt Institute, class of 1909 and was employed in the engineering office of the Erie Railroad from 1909 to 1915. In recent years he specialized on merchandising problems in the railway supply industry, including work for the American Arch Co., Franklin Railway Supply Co., Lima Locomotive Wks., The Superheater Co., Standard Stoker Co. and others. He was a member of the Engineers Club, the Transportation Club and the New York Railway Club.

Mr. Brown is survived by his wife, Mrs. Louise Macher Brown, two daughters, Miss Emilie Brown and Mrs. Louise Brown Blackler, and also a sister, Mrs. Annie B. Dobson.

Worthington and Moore Unite

WORTHINGTON PUMP AND MACHINERY CORP. of Harrison, N. J., has recently announced the acquisition of an interest in the Moore Steam Turbine Corp. of Wellsville, N. Y. This association adds to the list of products sponsored by Worthington an extensive line of steam turbine equipment and in turn provides Moore with the benefit of Worthington's resources in matters pertaining both to application and metallurgy.

In the formal announcement of this acquisition, C. E. Searle, Vice President of Worthington, stated, "It is the determination of both Moore and Worthington to continue the steady progress of development which has characterized the policy of Moore Steam Turbine Corp. throughout its existence. The fine reputation which Moore products enjoy in many industries, including the Petroleum, Chemical, Public Utility and Shipbuilding, is based upon a standard of quality which will be maintained."

Sheffield Farms Builds World's Largest Milk Plant

SHEFFIELD FARMS CO. have awarded the contract for complete refrigerating equipment for its new milk plant in New York City to Frick Co., Waynesboro, Penna. This plant, located on West 57th Street, will be the largest combined milk plant and distributing station in the world.

The refrigerating load will be divided into four main parts. A capacity of 320 t. of refrigeration will be required for cooling water to 34 deg. F. for use in the milk coolers, bottle washers, air conditioning equipment, and for ice making purposes; 60 t. of refrigeration will be used for cooling brine to 10 deg. F. for the box coils and unit coolers in the storage rooms; 100 t. of opaque ice is to be made daily; and cold brine must be supplied for making 60 t. of Flakeice per day.

For handling this cooling work Frick Company will furnish four of its 10-in. by 10-in. ammonia compressors, two of the machines being equipped with capacity controls. Two of the machines will be coupled to a single motor of 225 hp., the others being driven separately by 125-hp. motors. The compressors will discharge into four multipass ammonia condensers, each 38 in. by 18 ft. long.

Two brine coolers will also be of the multipass type, 38 in. dia., by 15 ft. long. A water cooling tank 28 ft. by 20 ft. by 5 ft. 9 in. will be equipped with 5400 sq. ft. of vertiflow coils. There will be two brine pressure tanks, a brine mixing tank and a brine defrosting tank. A total of 9 pumps will handle the cooling water and brine.

Two ice freezing tanks will be combined into one having partitions at the center; the total length is 120 ft., the width 22 ft., 6 in., and the depth 54 in. The cans will be lifted, a half row at a time, in grids. Two shell-and-tube brine cool-

ers, 46 in. dia. by 16 ft. 6 in. long will be submerged in the ice tanks which have double sets of auxiliaries throughout. Other auxiliary equipment will include an ammonia distiller, purger, 13 pressure gages and 19 thermometers. Nine thousand feet of 1¼-in. wrought iron coils are being supplied for the ice storage bins.

Mr. H. McNabb, engineer for the Sheffield Farms Co., is in charge of the construction of the new plant which is expected to be completed in the spring.

Diehl Celebrates 50th Anniversary

COMMENCING the celebration of its Golden Anniversary the Diehl Manufacturing Company, Elizabethport, New Jersey, held a general sales conference at the Elizabethport Plant, starting Thursday, January 6th and continuing until Tuesday, January 11th. The conference was called by Frank B. Williams, Jr. Vice President and Sales Manager to discuss plans for the sales promotion and advertising of the Company's many electrical products.

The Diehl Manufacturing Company is the Electrical Division of The Singer Manufacturing Company. They are pioneer manufacturers of Electric Motors, Generators and Fans for commercial, industrial, marine, public utility and residential use and distribute their products throughout the entire United States as well as in many countries abroad.

Paul B. Huyette

PAUL B. HUYETTE, engineering sales executive of Philadelphia, Pa., died January 13 after an illness of two weeks.

Mr. Huyette was 66 years of age, and for the past 43 years he had been the head of Paul B. Huyette Co., Inc.

He was a member of St. Paul's Lodge No. 481, F. and A. M.; St. Alban's Commandery No. 47, K. T., and the Philadelphia Consistory, A. A. S. R. He was also a member of the Engineers' Club, Penn Athletic Club and the Manufacturers' Country Club.

Mr. Huyette is survived by his widow, Julia V. Huyette, one daughter, Mrs. Vanetta Jones, of Baltimore, and a son, S. Louis Huyette, of Philadelphia.

Midwest Power Conference

ANNOUNCEMENT is made through the Armour Institute of Technology that the Midwest Power Conference will be held in Chicago, April 13 to 15, 1938. This new power conference is being conducted under the sponsorship of the Armour Institute in cooperation with six midwestern state universities and will replace the original conference which was organized under private and commercial sponsorship. The educational institutions involved have accepted the responsibility of the Power Conference because of the evident public service that can be rendered.

Plans are being arranged for the presentation of some thirty papers by accepted authorities drawn about equally from educational and industrial fields. Emphasis will be divided between steam, Diesel electric and hydraulic power. Present practice and possible future trends, as indicated by research laboratory work, will be dealt with in this paper presented.

The conference is open to all who are interested in power problems either from the technical, sales or production points of view. Headquarters will be at the La Salle Hotel in Chicago and anybody desiring information should address L. E. Grinter, Dean of the Graduate Division, Armour Institute of Technology, Chicago, Ill., who is acting as director of the conference.

N.I.A.A. Conference in Cleveland

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION will hold its 16th annual conference in Cleveland, Sept. 21-23, it has been announced by Stanley Knisely, advertising manager of Republic Steel Corp., who, as vice-president of the association, heads its committee for conference program and arrangements. Last September the association surpassed all its former attendance records with a registration of almost 800 at the Edgewater Beach Hotel in Chicago.

F. O. Wyse, advertising manager of Bucyrus-Erie Co., South Milwaukee, who at the meeting was elected N.I.A.A. president for the current year, characterized the whole year of 1937 as the busiest in growth and expansion of activities since its formation in 1922. New chapters were added in Toledo, Toronto and Indianapolis and a dozen different research and development projects were carried on in addition to the activities and regular monthly meetings of 15 local chapters.

Typical of some of these national committee activities was the recent development of publishers forms for three classifications of business papers, developed to provide more detailed and comparable data for space buyers and including editorial, or qualitative information, as well as additional industrial coverage and circulation data. Another report recently issued covered the influence of local dealers on the buying of space in trade papers.

For the Engineer's Library

Any Catalogs that you wish will be gladly sent. Write Power Plant Engineering.

Controls, Meters and Instruments

Level Meters—Liquid level meters of both electric and mechanical types are described in Publication 2090 issued by Cochrane Corp. These meters are adapted to a multiplicity of applications, in indicating and recording the level of water, oil and other liquid in tanks, boiler drums, reservoirs, lakes, etc. The bulletin presents full information concerning the details and operation of these meters. Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa.

Legibility Plus Precision is the title of a folder printed in seven colors reproducing the colored numeral records, exactly as they are printed on the chart of the Brown Potentiometer Pyrometer Recorders. It explains the significance of the Brown (+) Symbol, an exclusive feature, which is a part of each numeral record. The Brown Instrument Co. Division of the Minneapolis Honeywell Regulator Co., Philadelphia, Pa.

Remote Control Switches is the subject of Bulletin 920 A which has recently been issued by Automatic Switch Co. It is illustrated with drawings and photographs showing details of operations, accomplishments, advantages, etc. Automatic Switch Co., 154 Grand St., New York, N. Y.

Instruments—Two new bulletins, Nos. 602 and 650, issued by Wheelco Instruments Co., describe their "Capacitrol" and their "Proportioning Indicating Controller." The Capacitrol is a thermoelectric temperature measuring device operating in conjunction with an electron tube control circuit capable of extremely close regulation. The Proportioning indicating controller which is described in Bulletin 650, utilizes the same electron tube control system as the Capacitrol proportions the fuel input of a furnace to the demand and also controls and indicates temperature. Wheelco Instruments Co., 1929-30 S. Halsted St., Chicago, Ill.

Industrial Thermometers—Catalog No. 1125 B issued by C. J. Tagliabue Mfg. Co. describes the latest types of TAG thermometers, hygrometers, vacuum gages and barometers. Prices are listed in a separate section forming part of this catalog. C. J. Tagliabue Mfg. Co., Park and Nostrand Avenues, Brooklyn, N. Y.

Brown Automatic Boiler Regulation is the subject of Catalog 5001, issued by the Brown Instrument Co. It describes the steam damper regulator, over fire control, and control valves for boilers under 1000 hp. and operating pressure up to 300 lb. for many years sold as the A-Jacks regulators and controls of the National Regulator Co., now a division of Minneapolis Honeywell Reg. Co. The sale, engineering and service of these regulators has now been allocated to the Brown Instrument Co., division of the Minneapolis Honeywell Regulator Co., Philadelphia, Pa.

Ashton Industrial Gages, all of the Bourdon tube type and made in single and double tube styles, are illustrated and described in Catalog 38G of the Ashton Valve Co., 161-179 First St., Boston, Mass.

Pipings, Fittings and Accessories

Electrodes for Welding—For welding mild steel, the Murex Vertex electrode for reversible polarity and Genex for straight polarity are described in a pamphlet issued by Metal & Thermit Corp., 120 Broadway, New York City.

Prefabricated Piping—A story is told in pictures of the fabrication of welded piping and typical uses of such piping in a 24-p. booklet issued by Grinnell Co., Inc., 260 W. Exchange St., Providence, R. I.

Economical Pipe Sizes—Based on laboratory experiments, checked by actual operating results, a method of determining economical capacities of pipe lines for flow of fluids has been determined, that makes for substantial savings in installation costs and power used. Formulas are discussed, also effects of liquid density, viscosity, con-

dition of pipe, bends and fittings. These are reduced to easily used charts of velocity, pressure drop, amount of fluid and pipe size, covering various oils, water, brine, ammonia, gasoline, vapors and gases. A special chart is given for pipe coils; a table and another chart for lengths of pipe equivalent in friction to various bends and fittings; and a chart for conversion of viscosity as expressed in various systems into kinematic viscosity, thence into centipoise units for determining the Reynolds number. Derivation of the charts and illustrations of how to use them are presented by the author, F. L. Snyder, engineering department of E. I. du Pont de Nemours & Co. This material is given in Bulletin No. 108 issued by Tube Turns, Inc., 224 E. Broadway, Louisville, Ky. The charts are a convenient working tool for those having to solve any piping problems and will be sent on request to anyone interested in the subject.

Hancock Blowoff Valves is the subject of a 4-page Bulletin No. 8500. It describes the Blo-Deflector seat and disc design which is one of the new features of the valve. Hancock Valve Division of Manning, Maxwell and Moore, Inc., Bridgeport, Conn.

Safety Apparel, such as gloves, mittens, handguards, leggings, aprons or clothing, is described in a catalog under this title. The section describing asbestos gloves and mittens will be of particular interest to engineers who must handle hot metals as in welding operations. Industrial Glove Co., 700 Garfield Blvd, Danville, Ill.

Power Transmission, Tools and Maintenance

Boston Power Transmission Equipment is the subject of Catalog No. 52 which contains complete information on all Boston Power Transmission Equipment. It gives prices and specifications. Boston Gear Works, Inc., 955 W. Washington Blvd., Chicago, Ill.

Power Cost ½ cent per kilowatt hour is the subject of Bulletin 101, which tells how 43 leading concerns and institutions in 29 different industries cut power costs for driving 19 different types of auxiliaries. Troy Engine and Machine Co., Troy, Pa.

Texrope Catalogs — Revisions and Additions for the general Texrope Catalog have just been completed by the Allis-Chalmers Co. These include discount sheets, dated November, 1937, and revised information on adjustable pitch diameter sheaves, Texsteel drives using the new adjustable pitch diameter sheave, weights of Vari-Pitch sheaves and the Straitline Automatic motor base and the new adjustable Texsteel sheave. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Shafer Roller Bearings—A complete line of radial-thrust roller bearings and self alining ball and roller bearing units for a full range of industrial and machine applications are described and illustrated in catalog No. 14. Included with this catalog is an 8-page folder of list prices. The Shafer Bearing Corp., 35 E. Wacker Dr., Chicago, Ill.

Metal Sprayed Surfaces in Relation to Lubrication is the subject of a booklet by Harry Shaw, consulting and research engineer, which was read before an Engineering Society at Reynolds Hall, College of Technology, Manchester, England, October 20, 1937. It has been reprinted by and may be had on request to Metallizing Engineering Co., Inc., 44 Whitehall St., New York, N. Y.

Water Treatment and Heat Exchangers

Filters—Vertical and horizontal pressure filters are described in a new bulletin (Publ. 2760) issued by Cochrane Corp. These filters clarify water by removing suspended matter, such as silt, coal dust, and organic matter. The bulleting describes the chemical aspects of the process and presents comprehensive data on the operation and construction of the various types of units. Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa.

Clarifier System of continuous filtration of boiler water under pressure for increasing the effectiveness of internal boiler water treatment is described in Bulletin No. C-1 of the Clarifier Corp. of America, 6025 West 65th Place, Chicago, Ill.

Solving the Boiler Scale Problem with Sand-Banum—a pocket size pamphlet of 16 pages devoted to the characteristics and use of Sand-Banum which is a colloid preparation used to prevent the formation of scale in steam boilers as well as priming and foaming without danger of corrosion. Copies may be secured from the American Sand-Banum Co., Inc., 342 Madison Ave., New York, N. Y.

Water Analysis—Determination of sulfate by direct titration, using THQ, the procedure and equipment described in detail. Issued by W. H. & L. D. Betz, 235 W. Wyoming Ave., Philadelphia, Pa.

Organic Methods of Scale and Corrosion Control is a complete technical exposition of the application of Organic Chemistry in this field expressed plainly in understandable language. This 16-page booklet, the second edition, discusses and describes underlying principles and applications of organic chemistry. The booklet is profusely illustrated with graphs, formulae and equations of interest to the chemist and engineer responsible for scale or corrosion control in industrial operations. The application and properties of beta glucoside and the glucoside derivatives, including the recently developed hemi phospho glucosate, are described in detail. D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.

Alberger Heaters—A new catalog which describes the commercial types and gives considerable engineering data, dimensions, and other pertinent information. Also enclosed is an alinement chart to determine the correct sizes of openings and pipe lines. Howard Iron Works and Alberger Heater Co., 281-289 Chicago St., Buffalo, N. Y.

Pumps and Compressors

Morris Straightflo Pump—A bulletin on a unique type of centrifugal pump for handling large capacities at low heads has just been published by Morris Machine Works. This new bulletin, No. 167, describes these pumps in detail with exterior views, sectional drawings and dimensions of both horizontal and vertical types and with complete rating table showing the performance of the pumps from 10-in. to 24-in. sizes, for capacities above 1500 g.p.m. and for heads up to 40 ft. Morris Machine Works, Baldwinsville, N. Y.

Industrial Compressors and Vacuum Pumps is the title of a new bulletin recently issued by Ingersoll-Rand on their "Type 30" line, which ranges in size from ¼ to 15 hp. The bulletin, No. 2118, gives complete rating tables of more than fifty models in this classification, including their physical dimensions and shipping weights as well as their capacities, pressures, and rated horsepowers. Copies of the bulletin are available from the Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Deep Well Centrifugal Pump—This product is described in two new bulletins No. 265 and No. 1050 of American-Marsh Pumps, Inc. These bulletins show the features, construction and easy installation of this product. American-Marsh Pumps, Inc., Battle Creek, Mich.

Duplex Air and Gas Compressors are completely illustrated and described in a new 24-page catalog No. 180 of the Pennsylvania Pump and Compressor Co., Easton, Pa.

Combined Ammonia Refrigerating Units is the subject of the Frick Co.'s Ice and Frost Bulletin 104-H. It includes features, uses and specifications of the unit. Frick Co., Waynesboro, Pa.

Air Conditioning and Building Materials

Floor Surface—Rockflux resurfacer for concrete floors is described in a folder of Flexrock Co., 800 N. Delaware Ave., Phila., Pa.

Burt Free-Flow Fan Ventilator—A four-page pamphlet, under this title, describes an entirely new line of electrically powered fan ventilators which are built in three types known as regular, heat resisting and acid resisting types. The pamphlet contains tables of dimensions, capacities, motor data and weights. Burt Manufacturing Co., Akron, O.

Rotary Ventilators—Catalog Section B, Bulletin 205, points out the many features of this efficient ventilator. The Swartwout Co., Cleveland, Ohio.

IBS Protective Coatings is the subject of an 8-page catalog describing this new product which impregnates, bonds and seals the pores and surfaces of wood, concrete, metal or composition. It is highly resistant to acid, alkali and water. M. W. Kellogg Co., Jersey City, N. J.

The Dust Problem in Business—Dealing with such topics as Health to Men—Profits to Business, Methods of Dust Control Important, Profits from Dust Itself, Good Housekeeping, Combustion Dangers and Positive Control—Efficient Operation, F. A. Ebeling presents the first of a series of articles he is writing for publication in pamphlet form on the various phases of the dust problem. Copies may be secured from The W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland, O.

Stokers and Motors

Stoker—Details of Huber full automatic stoker with illustrations and method of operation are given in a 12-p. catalog issued by Flynn and Emrich Co., Holliday and Saratoga Sts., Baltimore, Md.

Vertical Motors—Vertical hollow and solid shaft polyphase, ball-bearing, squirrel-cage, induction motors are described in Bulletin 1410 of the Fairbanks Morse Co. Although these motors were developed primarily for direct-connection to vertical-shaft turbine, propeller and centrifugal type pumps, they have found wide application on special machine tools and various other industrial equipment. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.

New Engineering Books

SYMPOSIUM ON CORROSION TESTING PROCEDURES published by the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa., includes seven technical papers and discussion, presented at the 1937 regional and annual meetings. This volume of 131 p. covers principles of corrosion testing; atmospheric and salt-spray testing; electrical resistance method of determining corrosion rates; corrosion testing methods for copper alloys; standardizing liquid corrosion tests; and soil corrosion testing. Copies of this publication can be obtained from the society, at $1.25 per copy in heavy paper cover; $1.50 in cloth.

MECHANICAL WORLD YEAR BOOK (1938). Published by Emmott & Co., Ltd., 31 King Street West, Manchester 3, England. Size 4 by 6 in., 210 pp., cloth bound. Price 1/6 net (about 38 cents).

This is one of the most comprehensive and useful inexpensive handbooks published. In addition to the complete power plant, there are sections on gears, bearing, pumps, condensers, pipe work and useful tabulated data. This year a new section on electric arc welding has been added. It describes the types and properties of electrodes, explains the process in detail, and gives directions for the various methods of welding and for welding in different positions. Welding design is also fully treated, methods of calculation being given for butt and fillet welds.

Pursuing the scheme outlined in a previous edition—of alternating sections so that any two consecutive editions provide a greater store of data—there has been brought back into the new edition the section on Presswork which was omitted from the edition for 1937. The Metals and Alloys section has been omitted from the new edition, but will reappear in due course in revised form. General detail revision has been made as usual, and the index has been extended.

ACCOUNTING PRINCIPLES for Engineers. By Charles Reitell and Clarence Van Sickle. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Size 6 by 9 in., 512 pp., cloth bound. Price $4.00.

Probably no phase of power plant practice is handled more inadequately than records and accounts for cost control purposes. Engineers as a class fully appreciate the advantage of, and need for these figures, and in spite of the dearth of printed information dealing specifically with this problem, often set up elaborate and cumbersome systems to meet some specific need.

Unfortunately these seldom prove sufficient, and, as they are usually incomplete, often give a distorted picture. Accountants scoff at the clumsy efforts of engineers, and engineers jeer at the accountant's blind devotion to ritual. Neither appreciated the needs and desires of the other and even utility engineers have been driven to keeping their own records, independent of the general accounting system, in order to have available data necessary for intelligent operation and design.

Obviously if the engineer is to get the most out of the cost records at the minimum expense his cost-finding system should be part of, and tied in with, the general accounting system and both the engineer must have a basic understanding of the fundamental needs. Inasmuch as the accounting system is set up to meet financial needs and is sufficient unto itself, the engineer must approach the problem from the standpoint of the accountant, set forth his own needs clearly and within the limits of established accounting practice. This does not mean that the engineer must turn accountant but it does mean that he must be sufficiently familiar with cost accounting practice to translate his needs and desires into the accountant's language.

This book does not deal with cost accounting in the power plant. It is, however, a complete text written for the engineer interested in the fundamental principles of cost finding in manufacturing industries. As such it holds the key to power plant cost accounting for those sufficiently interested in their problem to study it through.

Step by step the reader is carried through the elementary technique of accounting to the more difficult principles and applications of cost finding. Each step is illustrated by examples and problems for the authors shape the text on the basic principle that the best preparation results from actually doing all accounting activities that cover or are related to the manufacturing enterprise.

Part I presents the basic accounting technique; Part II develops the fundamentals of asset valuation; Part III describes the use of control accounts and Part IV, the process of unit product cost finding. To obtain a working knowledge of accounting is no easy task and this book offers neither short cuts or quick mastery. What it does offer is a fully developed accounting technique, tested in practice and presented from a full background of teaching experience, to those engineers sufficiently interested to apply the fundamental principles to their own power plant or industrial cost finding systems.

DIESEL OPERATOR'S GUIDE and Data Book. Edited by L. H. Morrison. Published by Diesel Power and Diesel Transportation, 192 Lexington Ave., New York City. Size 9 by 12 in., 299 pp. plus 236 advertising pp. Price—red leatherette $6.00; green cloth, $5.00.

Because of variations in details and construction between different engines, general instructions and directions based on fundamental theory are of little value to an operator faced with the problem of operating and maintaining a specific engine. For this reason the editor of this book has presented a detailed operating manual covering some 27 engines made by 23 different companies. Similar data is presented for two fuel injection pumps, one governor and a centrifuge. One chapter in question and answer form covers the more common general problems that arise in operating practice. In addition 94 pages of the advertising section are arranged so as to give usable data on the equipment advertised. The book is well arranged, well illustrated and covers a range of specific data and information found in no other book.

FUNCTIONS OF THE PERSONNEL DIRECTOR. A report recently issued by Policyholders Service Bureau of the Metropolitan Life Insurance Co. is based on information obtained from 80 companies representing a wide variety of industrial and commercial enterprises, including these fields: automotive, electrical, foundry, iron and steel, machine tool, meat packing, paper, petroleum, rubber, textile, banking, chain and department store, insurance, mail order and public utility. The report indicates that the personnel function is twofold. It consists, first, of giving service to the line organization in the maintenance of an efficient labor force and, second, of establishing good relations with employees. Regardless of the existence of an organized personnel department, every company finds it essential to hire new employees, place them at work for which they are adapted, transfer them to other departments to meet production requirements, and surround them with helpful and safe working conditions. Personnel Management thus has grown both logically and historically out of the employment function. More recently, however, greater emphasis has been placed on the development of a cooperative attitude of mind by establishing good industrial relations throughout the organization.

The report outlines the personnel policies and programs of leading companies, describes the place of the personnel director in industry and business today, and indicates how personnel departments are organized. Because there are conditions in every company that make for either good or bad industrial relations, the report concludes that these conditions should be studied and brought under managerial control.

Copies of "Functions of the Personnel Director" may be obtained from the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Avenue, New York, New York.

SMOLEY'S SEGMENTAL FUNCTIONS Text and Tables. By C. K. Smoley. Published by C. K. Smoley & Sons, Scranton, Pa. First edition. Size 4 by 7 in., 480 pages, leather bound. Price $5.00.

The aim of the author in writing this book was to facilitate calculations involving circular work. He did this by creating a new mathematical entity, Segmental Functions, which accomplish for the solution of the circular segment what trigonometric functions have done for the solution of the triangle. A triangle has six parts and when three of these, of which at least one is a side, are known, trigonometric functions offer a means of computing the other three parts of the triangle. In a segment there are five parts: (1) the arc, (2) the chord, (3) the radius, (4) the central angle subtended by the arc, and (5) the height, or the middle ordinate referred to the chord as abscissa, and when any two of them are known the segmental functions offer a means of computing the other three.

To simplify this work, the author has used the logarithms of the segmental functions instead of the functions themselves and has evolved a set of formulas which are well adapted for logarithmic work. There are 438 pages of tables included in this edition.

Power Plant Construction News

Ark., Paragould—City Council is considering a special election in April to approve bonds for $100,000 for a proposed municipal electric power plant, estimated to cost about $190,000. Balance of fund will be secured through Federal grant. Plans for station will be completed soon.

Colo., Denver—Oriental Refining Co., Equitable Building, Max P. Zall, president, plans installation of power equipment in connection with extensions and improvements in oil refining plant at Colorado Boulevard and Fifty-second Avenue, where plant formerly owned by other interests has been acquired. Pumping machinery, tanks and other kindred equipment will be installed. Entire project will cost about $150,000.

Conn., Hamden—New Haven Paper Box Co., 214 East Street, New Haven, Conn., plans installation of electric power equipment in new paper box-manufacturing plant at Welton and Burton Streets, Hamden, where site was acquired recently. Entire project is reported to cost close to $50,000. Charles H. Abramowitz, New Haven, is architect.

Fla., Miami—Florida East Coast Growers' Association, 109 S. W. First Street, plans installation of electric power equipment in new mechanical-bottling plant, 45x150 ft., at 2055 N. W. Seventh Avenue. Work will begin soon. Entire project will cost close to $60,000. H. W. Bird is manager.

Fla., Miami—Florida National Building Corporation, Miami, plans electric power plant, using Diesel engine-generator units, for light and power service for new 16-story bank and office building now in course of erection at Flagler Street and Second Avenue. Cost estimated at $250,000, with equipment. Work is scheduled to begin soon. Henry L. Dew is vice-president.

Ill., Geneva—City Council, Victor G. Johnson, city clerk, is considering preliminary plans for extensions and improvements in municipal light and power plant, including installation of new Diesel engine-generator units and auxiliary equipment. Cost estimated close to $250,000. Wells Engineering Co., Court House, Geneva, is consulting engineer.

Ind., Delphi—Globe Valve Co., 2925 East Fifty-fifth Street, Cleveland, Ohio, plans installation of electric power equipment in new one-story plant at Delphi, where site has been acquired, 60x300 ft., for valve and kindred engineering products manufacture. Entire project will cost about $75,000. Max Gerber is president.

Ind., Huntington—Board of Public Works, City Hall, plans extensions and improvements in waterworks pumping station, including installation of Diesel-electric units for electrification of plant. Surveys and estimates of costs have been authorized. J. Y. Dahlstrand, Burlington, Iowa, is consulting engineer.

Ind., Kokomo—Indiana Steel & Wire Co., East Jackson Street, plans installation of electric power equipment in two new one-story plant additions, 130x260 ft., and 40x53 ft. Entire project will cost about $100,000.

Kan., Stafford—City Council is considering extensions and improvements in municipal power plant and waterworks station, including installation of a new 450-hp. Diesel engine unit and auxiliary equipment. Estimates of cost are being made. Paulette & Wilson, 1006 Kansas Avenue, Topeka, Kan., and Farmers' Union Building, Salina, Kan., are consulting engineers.

Ky., Beattyville—Bond issue of $90,000 for a municipal light and power plant, previously reported in these columns as having been approved, has not received a favorable vote, and project will not be carried out at this time.

Ky., Louisville—Porter Paint Co., Fourteenth and Cedar Streets, plans installation of electric power equipment in new three-story and basement addition to paint and varnish-manufacturing plant. Entire project will cost over $80,000. Walter C. Wagner, Breslin Building, Louisville, is architect and engineer.

La., Opelousas—Opelousas Cotton Oil Mill Co., plans installation of electric power equipment in new additions to cottonseed oil mill. Entire project will cost about $100,000 and is scheduled for completion next spring. J. P. Barnett is president.

Md., Popes Creek—Southern Maryland Tri-County Co-Operative Association, Welcome, Md., Wendell M. Holmes, president, has plans maturing for new electric generating station in vicinity of Popes Creek, for power supply for rural electric system. Plant will cost about $50,000. Financing is being arranged through Federal aid.

Mass., Boston—Boston Edison Co., 39 Boylston Street, has filed plans for extensions and improvements in steam-electric generating station on Bridge Street, Weymouth, including installation of additional equipment. Cost estimated close to $250,000. Jackson & Moreland, 31 St. James Avenue, Boston, are consulting engineers.

Mass., Everett—Boston Elevated Railway Co., 31 St. James Avenue, Boston, plans installation of electric power equipment in new mechanical and electrical shop for car and bus maintenance and repairs, on site on Broadway, Everett. Cost estimated close to $1,000,000. A. J. Blackburn, first noted address, is company architect, in charge.

Mich., Adrian—Bohn Aluminum & Brass Co., Lafayette Building, Detroit, Mich., plans installation of power equipment in new one-story plant at Adrian, 100x185 ft. A boiler house, 35x35 ft., also will be built. Entire project is estimated to cost close to $100,000. Proposed to begin work at early date.

Mich., Kalamazoo—City Council has plans nearing completion for extensions and improvements in municipal electric light and power plant, including installation of additional equipment. Cost estimated close to $275,000. Proposed to begin work at early date. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

Mo., La Plata—City Council is completing plans for proposed municipal light and power plant, and will begin work on project in near future. Fund of $100,000 has been arranged through Federal aid.

Neb., Franklin—Common Council plans extensions and improvements in municipal electric power plant, including installation of a new generating unit and auxiliary equipment. Estimates of cost are being made. Harry Robinson is city clerk.

N. J., Linden—General Motors Corporation, Linden Division, Edgar Road West, plans installation of electric power equipment in new one-story addition to local automobile assembling works, to be used for expansion in inspection division. Entire project will cost about $80,000. W. S. Roberts is general manager at plant.

Pa., Avis—Jersey Shore Steel Co., Jersey Shore, Pa., recently organized, plans installation of electric power equipment in connection with remodeling and improving former steel mill at Avis, which has been acquired for new plant for production of rails, bars, etc. Entire project will cost about $200,000. John A. Schultz, formerly president of Sweet's Steel Co., Williamsport, Pa., heads new company.

Pa., Butler—General State Authority, 600 North Second Street, Harrisburg, Pa., A. S. Janeway, executive secretary, plans steam power house at new Western State Sanitarium at Butler, with installation to include two 600-hp. high-pressure boiler units, automatic stokers and auxiliary equipment, with 165 ft. radial brick stack. Cost about $160,000. Bids for station as well as other buildings at institution are scheduled to be asked in March. Entire project will cost over $2,000,000.

Tenn., Knoxville—City Council, W. W. Wyatt, city manager, plans early call for bids for about 1,000,000 ft. of copper wire, poles, pole hardware and fittings, meters and accessories for municipal electric distributing system. Award will be known as Contract No. 1 and is estimated to cost about $175,000. Bids for other equipment will be asked closely following. Entire project will cost approximately $2,500,000. Financing has been arranged through Federal aid. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

Texas, Dallas—Coca-Cola Co., 310 North Avenue, N. W., Atlanta, Ga., plans installation of electric power equipment in new multi-unit mechanical-bottling and beverage manufacturing plant at Lemmon Street and Mockingbird Lane, Dallas, where tract of land has been acquired. A power house will be built. Entire project will cost close to $1,000,000. Robert & Co., Bona Allen Building, Atlanta, are architects and engineers.

Texas, Mesquite—Men's Luncheon Club, Mesquite, is at head of project to construct and operate a municipal cold storage and refrigerating plant. N. E. Mikel and C. G. Parker are head of committee in charge, to secure details of equipment and estimates of cost.

Va., Dry Fork—Dry Fork Milling Co., plans installation of power equipment in connection with proposed rebuilding of portion of grain and feed mill recently destroyed by fire. Loss estimated close to $80,000.

Wis., Clayton—Stella Cheese Co., Metropolitan Bank Building, St. Paul, Minn., has plans for new steam power house at plant at Clayton, with installation to include two 150-hp. boiler units and auxiliary equipment. Proposed to begin work soon. Ralph W. Richardson, Oppenheim Building, St. Paul, is consulting engineer.